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The Development of the Photographic Lens

By H. W. Lee[1]

THE writer of this article, Mr. H. W. Lee, is a graduate of Cambridge University, England, and has for many years been one of the outstanding lens designers of modern times. He is associated with the well-known firm of Taylor, Taylor and Hobson, Leicester, England, and has done much toward the development of the modern ultra-high-speed lenses necessary for kinematography indoors. He is particularly qualified therefore to review this subject for THE GLASS INDUSTRY.

The qualities of glass most important to the optician (beside the physical and chemical ones of transparency and stability) are the "refraction" or bending imparted to a ray of light, and the "dispersion," i.e., the difference in the amount of refraction between one color and another. Refraction enables the optician to form an image with a lens, dispersion spoils that image with color fringes. Newton, the great English optician, came to the erroneous conclusion that it would be impossible to cure this defect, but later, in 1753, Chester Moor Hall found experimentally that by combining a convex lens of crown glass with a concave one of the flint glass which had been introduced for the manufacture of fine table ware, he could do so. Thus was the first "achromatic" telescope object glass made (Fig. 1), giving a great impulse to the study of astronomy.

The camera obscura was invented by the artist Leonardo da Vinci as an aid to artists; an image of, for example, a landscape was thrown on translucent paper at the back, by means of a lens at the front; this image could be traced. The lens used had to be of a different type from that used in the telescope, as the image, though it was not to be enlarged as in the telescope, had to be of larger extent. Wollaston invented the "periscope" lens (Fig. 2) for this purpose in 1812. On the invention of photography it was natural that the old camera obscura should be converted, by the substitution of a sensitive plate for the translucent screen, into the photographic camera, using the Wollaston lens. It was soon found, however, that the focus of the lens for the rays active on the photographic plate was different from that for the visual rays. To bring the two foci into coincidence the Wollaston lens was "achromatized," as the telescope lens had been, and the "landscape" lens was formed (Fig. 3). The sensitivity of the photographic material then available was not great and the commercial exploitation of the new science, chiefly for portraiture, required a more rapid procedure. Now the rapidity of a lens depends on the ratio of the diameter to the focal length; but the greater this is, the worse the image formed is, owing to "aberrations" of the lens. To increase the rapidity of the lens was thus the next task of the optician, and this was accomplished by the skill of the Viennese mathematician Joseph Petzval (1807-1891), in 1840, who computed the lens which bears his name, which is still in use today. His lens (Fig. 4), had a diameter one quarter its focal length (expressed as F/4), and was thus twelve times as fast as the landscape lens (F/14).

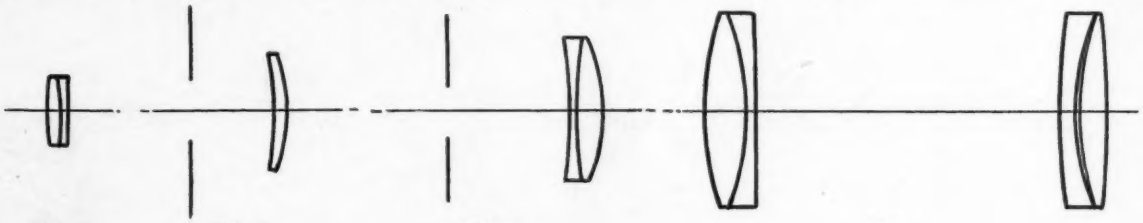


FIG. 1 FIG. 2 FIG. 3 FIG. 4

Passing over some tentative forms arrived at empirically, the next important development was the Rapid Rectilinear (as it was known in England) or Aplanat (the name by which it was known in Europe), which may be considered as the symmetrical assembly of two landscape lenses, of a particu-

[1] Leicester, Eng., of Taylor, Taylor & Hobson.

lar form however, as all the component lenses were meniscus in shape (Fig. 5), and all were made of flint glass—a light flint for the "crown" and a dense flint for the "flint." This lens was introduced into England by Dallmeyer, and on the Continent by Steinheil, practically simultaneously. It enjoyed a great vogue for many years—until the introduction of the "anastigmat" in fact.

Although there was thus a rapid lens for portraiture and another type for "general" work these all suffered from the defect that the image at the edge of the photographic plate

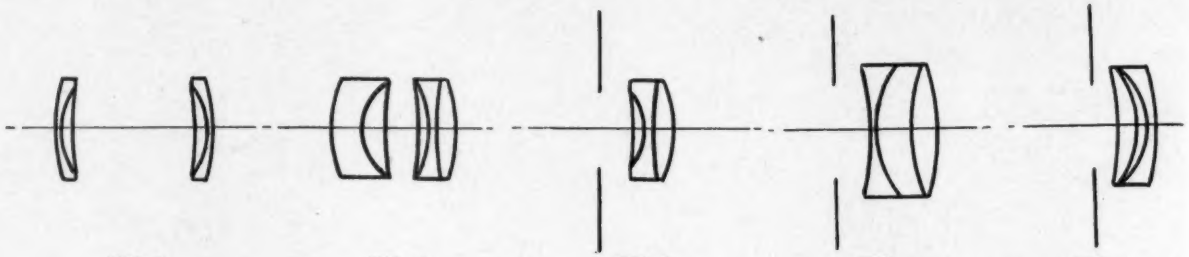


FIG. 5 FIG. 6 FIG. 7 FIG. 8 FIG. 9

was not so good as that in the centre; this was because the "field" of the lens was curved, i.e., the images of objects away from the axis of the lens were formed nearer to the lens than those on the axis. Petzval had investigated mathematically the condition for designing a lens that would form a flat image of a flat object, but found that with the types of glass

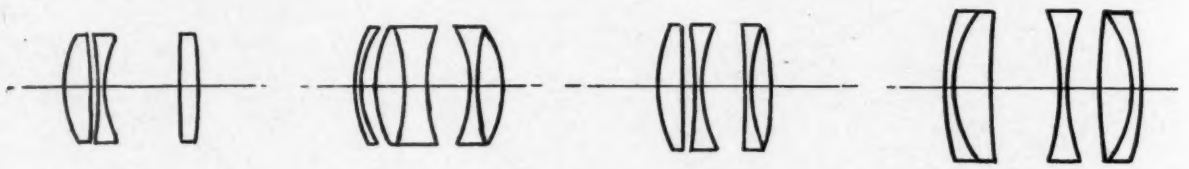


FIG. 10 FIG. 11 FIG. 12 FIG. 13

available these were inconsistent with those for "achromatizing"; lens design was thus brought to a standstill.

Hitherto the glassmaker had not done much for the optician. There were only two types of glass available, crowns made for window glass, and flints made for tableware; and there were not many varieties of these types either. No optical data were supplied by the glassmakers; the usual way of specifying a glass was by its density. As it happened, from the limited number of materials used in glassmaking, the density was a very fair measure of the refraction and of the dispersion (the two being connected by a straight line law—this very fact precluding the fulfillment of the "Petzval Condition" for a flat field). J. Fraunhofer early in the nineteenth century had shown how the refractive power of glass could be accurately specified by reference to "Fraunhofer's Lines" in the solar spectrum, which he discovered. He also started those improvements in glass manufacture which are the basis of modern practice in the production of optical glass. The systematic investigation of new types of glass began in England with Faraday and was continued by Vernon Harcourt and Prof. Sir G. G. Stokes, but no very considerable advance on a commercial scale was made till Schott and Abbe in Germany started their great work at Jena, in 1884, aided by a Government subsidy. The result of this combination of scientist and manufacturer was the production of new types of glass and it at last became possible to design a photographic lens having a flat field—the type known as "anastigmat." Opticians were not slow to take advantage of the new material and Rudolph, followed by v. Hoegh, Harting and Steinheil, in Germany invented the systems known as the "Protar" (Fig. 6), "Dagor" (Fig. 7; half the lens only drawn), the "Collinear" (Fig. 8, half lens), and "Orthostigmat" (Fig. 9, half lens), respectively. In England H. D. Taylor was hardly behind the Germans with his "Cooke" lens (Fig. 10), followed by H. L. Aldis with his "Stigmatic" (Fig. 11). The form favored by the Continental opticians is seen to be that of two symmetrical combinations each consisting of three or four lenses of different glass cemented together. The English opticians preferred an assembly of separated lenses; Taylor, by a stroke of genius, evolved the simplest form of all—three simple lenses separated by air spaces, using only two kinds of glass, the new dense or medium crown and light flint. The rapidity of the Continental type was usually F/8 (i.e., the diameter of the lens was one eighth the focal length) which was afterwards increased to F/6.8. The English type was made in various forms having apertures from F/8 to F/3.5. At first the general purpose lens was considered sufficiently rapid if it had an aperture of F/8 to F/6 and covered a field of 50° to 60°. The special lenses for portraiture having an aperture of F/5.6 to F/3.5, covered a narrower angle.

As photography increased in popularity and faster and faster moving objects came within its scope, the desire was felt for faster lenses with the same covering power, and in the second decade of the nineteenth century the aperture of the general purpose lens had increased to F/4.5. For this the type with separated lenses was found to be most favorable, so that the F/4.5's fell into one or other of the following classes: Cooke lenses or modifications of it such as the Zeiss "Tessar," designed by Rudolph and Wandersleb, in which the back lens was replaced by a compound lens (Fig. 12), and Voigtländer's "Heliar" in which both front and back lenses are compound (Fig. 13): four lens combinations were the Goerz "Dogmar," Steinheil "Unofocal" and Taylor,

Taylor and Hobson "Aviar," all consisting of two double concave lenses between two convex lenses (Fig. 14): another four lens type, consisting of meniscus lenses was made under various names in different countries (e.g., Taylor, Taylor & Hobson Wide Angle, Meyer "Aristostigmat"; Ross "Homocentric," Rodenstock "Eurynar," Busch "Omnar," etc.), at apertures ranging from F/8 to F/5.6 (Fig. 15 shows half the lens). Developments of this type are the Zeiss "Planar"

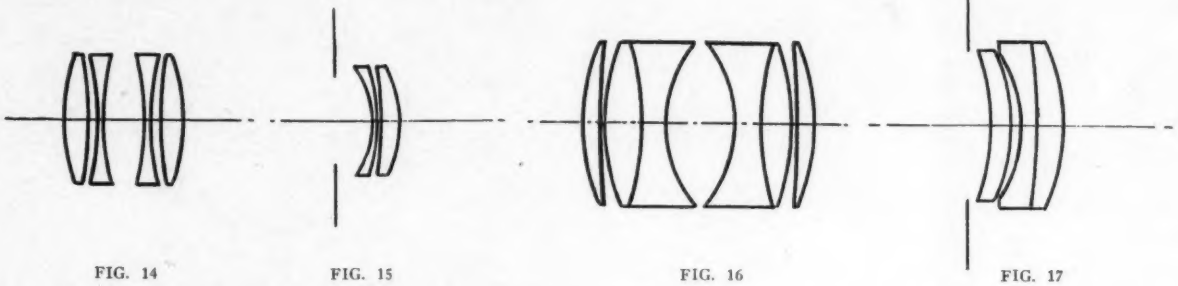


FIG. 14 FIG. 15 FIG. 16 FIG. 17

which had the large aperture of F/3.5, where the inner, negative components were cemented pairs (Fig. 16), and the Meyer "Plasmat" having an aperture of F/4 or D/5.5

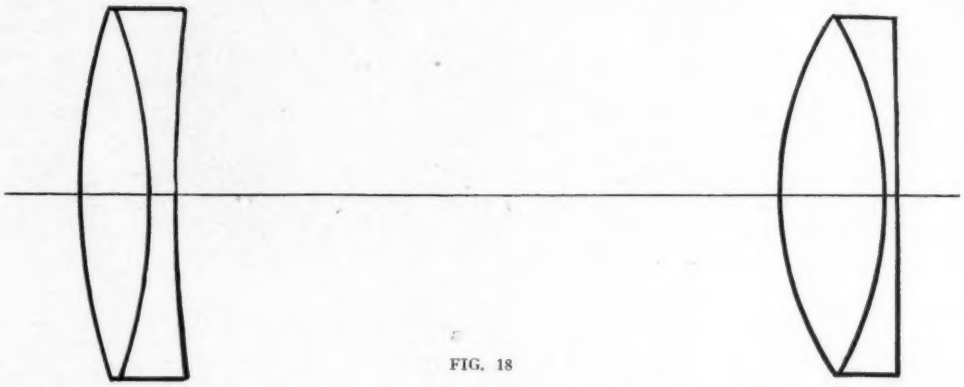


FIG. 18

(Fig. 17 shows half the lens); here the positive components are placed inside.

The phenomenal rise of cinematography and particularly of amateur cinematography has given a further impetus to

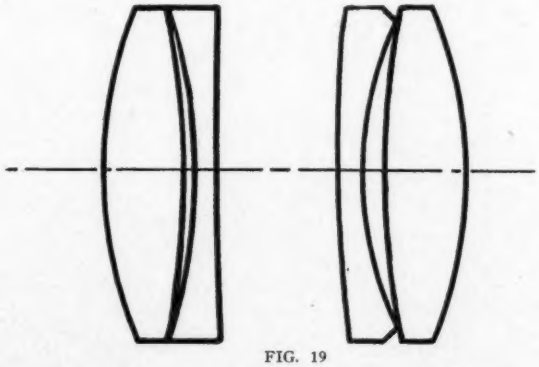


FIG. 19

the production of rapid lenses. When films were produced in artificially lighted studios, a rapid lens meant saving in current and became of commercial importance. Similarly, as projection screens and cinemas became larger, it was more and more necessary to get as much light through the projection lens as possible. The old Petzval lens was called upon to take a new lease of life as a projection lens, the aperture ratio being increased to F/2 or F/1.8; examples are the Taylor, Taylor & Hobson "Maximum" (Fig. 18) and the Kodak projection lens (Fig. 19). Afterwards the ratio was increased still further by further modifications of design to F/1.5 (Taylor, Taylor & Hobson, Fig. 20) and F/1.3 (Dallmeyer). But the old limitation of a curved field still handicaps the lens, so that for taking lenses cinematography is dependent on the latest developments of the anastigmat. The modern superspeed lenses have developed chiefly in two well-marked directions. The original Cooke triplet, itself improved to yield an aperture of F/3 or more, has been modified in various ways. The Tessar modification has been made in apertures up to F/2.7. By replacing both single positive lenses by cemented doublets L. B. Booth has made the "Pentac," F/2.9 (Dallmeyer, Fig. 21); by dividing the back into two separate components the aperture has been increased to F/2.5 (Taylor, Taylor & Hobson, Fig. 22); by subdivision of the front components and making one or more of the components compound Ernemann has increased the aperture to F/2 and F/1.8 (Fig. 23); by division of the middle negative component and replacing the single positive members by doublets Rudolph has brought out the Kino-Plasmat F/2 and F/1.5 (Meyer, Fig. 24).

Thus the Cooke triplet has proved itself a stayer in the race for speed. The other lens development has been from the Rudolph "Planar." Lee increased the aperture of this form to F/2 (Taylor, Taylor & Hobson, Fig. 25) and F/1.5. Zeiss has also successfully exploited this form in the Biotar F/1.4.

It is thus seen that today there are perfectly good lenses having apertures of F/2, F/1.8 and F/1.4, available in the small sizes required for cinematography. The aperture F/2.5 or F/2 is available in larger sizes for lenses for ordi-

nary photography. There is a physical limit to the useful size of photographic lenses however, because as the diameter gets larger the range of distances at which objects can be sharply focused on a photographic plate decreases; the range, in fact, decreases as the square of the diameter of the lens (on the physical theory of optics). Nearly always the objects within the angle of view of the lens lie at different distances from the lens; even a single object, such as the

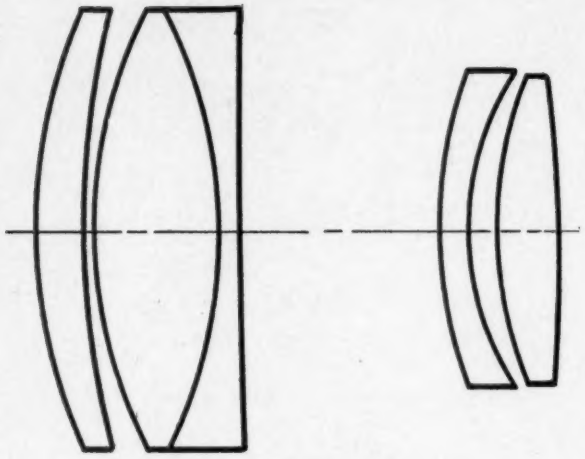


FIG. 20

human face, does not usually lie all in one plane. Hence physical conditions impose a limit to the diameter (and hence to the aperture ratio, since the focal length cannot be reduced indefinitely). Faster lenses will not then be of great use even if they can be designed to give a perfect image of a flat object. In what direction are we then to look for

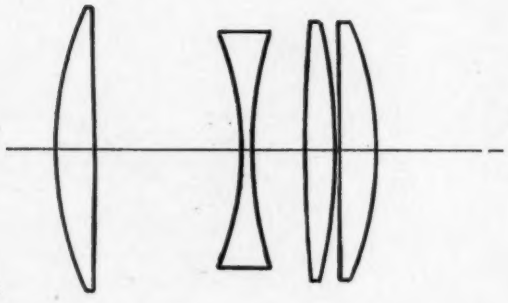


FIG. 22

optical progress? It will be noticed that the faster lenses of today are more complicated in structure than the earlier types. The Cooke lens for example was a simplification of an earlier form: is it possible that the same progress will be possible in the present lenses of extreme aperture? I think this will largely depend on the glassmaker. Very little extension of properties in the optical glass available today has taken place since Schott introduced his Barium Crowns and Light Flints. As an example of the importance of new glass as leading to improvements may be mentioned the case of the Zeiss Protar. As originally made it had an aperture of F/8 to F/6.8. Ross's, during the war, taking advantage of newer glasses was able to extend the aperture to F/5.5, while Lee, using the newly introduced Fluor Crown glass, increased the aperture still further to F/4.5. The introduction of new

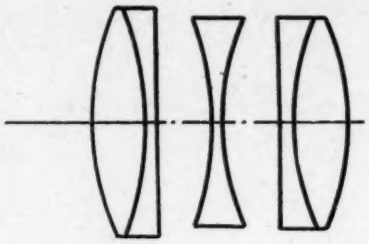


FIG. 21

types of glass, besides leading to improvement of existing types either in their optical properties or in simplification of manufacture may introduce altogether a new standard of correction; e.g., it is possible that advances may be made in the color correction. When color in the image was first "corrected" it was understood that two colors were brought into coincidence. Now if we consider the primary colors used in three color work, by which a perfect reproduction of all colors is possible, it is found that amongst the usual types of glass the ratio of the dispersion between red and green for any two glasses is not the same as that for green and blue, so that it is never possible to equalize the focal lengths for red, green and blue, and bring the foci for these colors into perfect coincidence. The red and blue may be made to coincide, leaving the green a little short, or the red and green

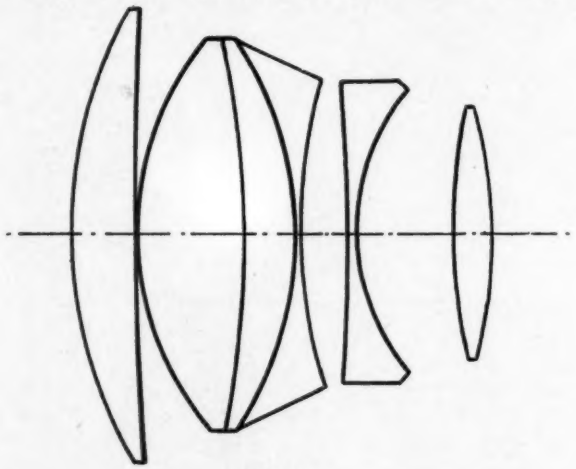


FIG. 23

may coincide, with the blue long. There is, however, one particular flint, known as Telescope Flint, which can be used with certain crown glasses to produce a lens in which red, green and blue images all coincide—the so-called apochromatic lens. This type is used in three color process work where lenses of very great focal length are necessary, so that if ordinary lenses were employed the separation between the images would be serious. In the shorter focal lengths of ordinary photography and cinematography, with their large

apertures the serious limitation in the optical properties of the special Telescope Flint leads to great complication of structure if apochromatism is aimed at (see e.g. British Patent No. 321,078). The increasing use of panchromatic emulsion and color cinematography are making the apochromatic correction more and more desirable so that it is greatly to be hoped that the glassmaker will soon be able to produce these special glasses in greater range.

Another direction in which the range of glasses could with

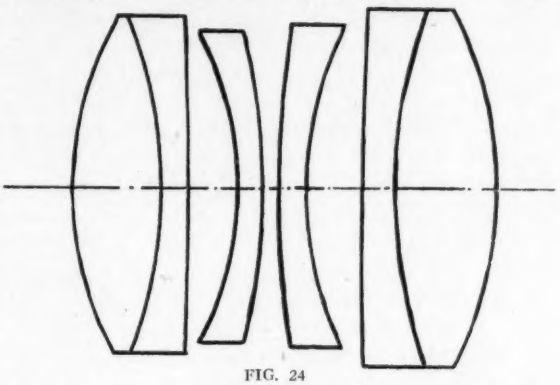


FIG. 24

advantage be extended, is in the production of denser barium crowns. At present about 1.623 is the highest refractive index reached, which represents but a slight advance on Schott's list of 46 years ago. An increase to at least 1.65, with the small dispersion characteristic of the present barium crowns, is desirable from the point of view of the lens designer.

Still another advance would be registered if existing optical glasses could be improved as to their stability. Dense barium crowns at present are liable to atmospheric corrosion which, even if not serious from the optical point of view, is of great disadvantage commercially, from the prejudice aroused by the unsightly appearance of these glasses when badly tarnished. Opticians are at present trying to avoid the use of the denser glass in those parts of the objective most exposed to the atmosphere. It would be a notable improvement if the stability of the medium barium crowns could be extended to the denser ones.

Progress in optical design has been shown to be periodic,

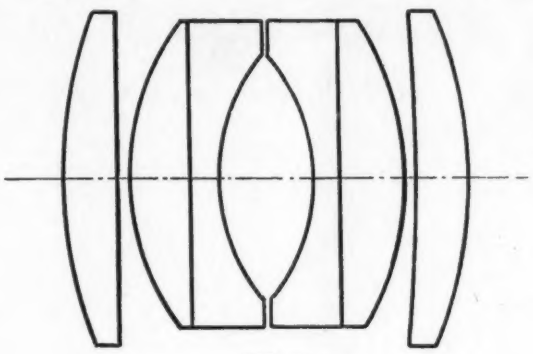


FIG. 25

each periodic advance having been due to some improvement in glass.

With the introduction of fresh types of glass there has been a leap forward in optical design, followed by a more gradual advance as the full possibilities have been painstakingly explored, till finally progress has slowed down. Have we arrived at such a stage today? It is possible. Is further improvement in lens design unlikely till the glass maker comes forward with fresh glasses having strikingly useful properties? It is probable.

The Glass Man and the House Fly

The following very interesting letter appeared in *Nature*.[1]

COLORED GLASS AS A DETERRENT TO HOUSE FLIES

Some years ago Messrs. W. P. Hartley, Ltd., jam manufacturers, Aintree, glazed their storage warehouses with yellow glass. The warehouses are connected by corridors which were glazed with ordinary glass. They noticed that whereas there were always plenty of flies in the corridors these never went into the warehouses. They then glazed the corridors with yellow glass, and found that they got rid of the flies from these also.

We have heard of other instances where colored glasses have been used as a deterrent for flies, and we understand that some abattoirs have been glazed with blue glass.

As we were continually being asked for advice on this subject, we decided to carry out some experiments in an endeavor to ascertain whether the house fly was susceptible to colored light, and if so, which color was the best deterrent. We carried out a series of experiments last summer under advice from Prof. R. Newstead, and found that, everything else being equal, the house fly prefers white light to colored light, and that red and yellow are the best deterrents. Blue and green are not nearly so effective. The loss in illumination with red glass being too great for general use, it appears that yellow is the best.

Although it cannot be claimed that the use of yellow glass is an absolute preventive, it is a very effective deterrent, and valuable for use in connection with the storage of food.

We do not suggest the use of yellow glass for any building in which people are continually employed, because it has been found that yellow light is bad for the eyes and general health.

We cannot find a record of any work on this subject, and intend to continue our experiments during the coming summer. In the meantime we wonder whether any readers of *Nature* have noticed this peculiar attitude of the house fly towards colored light and can offer any explanation.

(Signed) PILKINGTON BROTHERS, LTD.

CROWN GLASS WORKS,
St. Helens, Lancs., England.
March 17, 1930.

Two other letters on the subject, published later in the same journal, issue of May 24, 1930, are reproduced below:

Last autumn we received an inquiry from Mr. L. Macqueen Douglas, of Newpark, Mid Calder, Midlothian, who asked us whether we had any data concerning the action of colored glass on house flies. In his experience colored glass, especially blue, acted as a deterrent, and he was using it in the construction of abattoirs, etc. At that time we were unable to obtain any further information upon the subject. On the appearance in *Nature*, of April 5, of the letter from Messrs. Pilkington Bros., who stated that red and yellow are the best deterrents and that blue and green are not nearly so effective, I communicated these facts to Mr. Douglas. He replied stating that he had carried his experiments somewhat further, and that from his experience blue glass is to be preferred to yellow for two reasons. First, he found that the blue glass was completely effective in preventing the development of flies; and secondly, that the blue glass does not give an offensive look to the meat, while yellow glass gives it

[1] *Nature*, April 5, 1930, P. 529.

an unhealthy-looking color which from a commercial point of view is highly objectionable.

I might add that Mr. Douglas's experience of abattoirs and their construction is very extensive.

A. D. BUCHANAN SMITH.

University of Edinburgh, May 1.

Messrs. Pilkington Bros., in *Nature*, of April 5, raise an interesting point regarding house flies and their dislike of light of certain hues. The following observations, made during September of last year, may be of interest.

Two similar small rooms were roof-glazed, one with ordinary rolled-plate, the other with a proprietary heat-absorbing glass transmitting bluish-green light. Ventilators in the two rooms gave insects equal opportunities for ingress, but at the end of a fortnight the numbers of insects in the rooms were so obviously unequal that a count was made, with the following result:

Type of Insect	Under Clear Glass	Under Bluish-Green Glass
Flies	19	8
Moths	4	1
Wasps	4	0
Spiders	3	0

It should be added that, during hot weather, the maximum air temperature in the room glazed with rolled-plate was usually 5° or 6° F. greater than that in the other room. There was also a marked deficiency of infra-red radiation beneath the bluish-green glass which may partly account for the results obtained.

Building Research Station, Watford. H. E. BECKETT.

It has been known for some years that insects in general are attracted to certain colors in preference to others. By putting out cloths of different colors on a summer day, it may be found in many instances that small flies and other insects will settle on some and not on others. In some cases they are manifestly attracted to those colors that most resemble the flowers they habitually frequent. We presume that flowers have come to be colored because they can thereby attract insects, and enable the insects more readily to distinguish between flowers and green leaves.

However the house fly is not a flower-frequenting insect so far as we know, though, as it is a sucking and not a biting insect, and likes sugar, it is no doubt descended from a flower-frequenting type.

Everyone knows that the house fly is attracted by warmth; it will sit in the sunshine when possible, and roost at night on the ceiling, where the last warm air remains. Is it possible that it objects to, or at least is not attracted to, those red and yellow glasses that cut out the infra red? Or are the glasses obnoxious because they cut out the ultraviolet and blue?—*F. W. P.*

Pressing Glass

By ROY E. SWAIN

WITH the glass in the mold, the mold is placed beneath the plunger and the plunger caused to descend and form the inner surface of the article. This movement in hand pressing is usually accomplished by means of a toggle or a rocker-shaft and connecting rod arrangement. In this manner the plunger is quickly brought in contact with the glass, then with decreasing speed and increasing power the glass is forced into the outer and upper portions of the mold. This type of equipment is so common that it is scarcely necessary to use a diagram of forces to show to what extent this increase of power may be had. By calculation it can be shown that often a pressure of eight or ten tons may be used in pressing an article less than ten inches in diameter. In making these calculations it must be assumed that the amount of glass can be controlled to cause the mold to fill shortly before the toggle reaches dead center.

In making a study of the flow of glass and making allowances for the surface chill and the increasing viscosity near the surface, one can readily see that a thin article must require a greater amount of pressure to produce a given flow than would be required in a heavier article. Perhaps no two articles would plot the same weight and pressure curves, nor would a composite of a number of representative curves agree with the pressure curve plotted for the toggle. However the general trend is such that the pressure is able to make articles of varying weights in the same mold with but slight difference in exertion. This feature of the toggle has been overlooked by the designers of both automatic and semi-automatic presses who wishing to simplify the mechanism of their presses permitted the toggle to go over center. To make allowances for the inevitable variations in the weights of the mold charges a spring or other pressure release is placed on the plunger shaft and the pressure acts through this spring. By this arrangement when the amount of glass in the mold charge exceeds that required to fill the mold the spring is compressed. This creates a condition just the reverse of the one previously described for by this arrangement the heavier article receives the greater pressure. This results in straining the heavier articles and damaging the molds. These machines under very skilful management will produce but their flexibility is so low that the management sooner or later decides to discard them.

Another factor plays an important part in pressing: this is the spring pressure used to hold the mold ring in place. These springs attached to the plunger shaft play a multiple role. They not only hold the ring in position but cushion the plunger and store up the force necessary to throw the plunger out of the glass and carry the lever back to a point where the counterweights will become effective. The article having a wide flange made under the ring increases the problem of holding the ring in place, for although it would be necessary to make allowance for the viscosity of the glass in applying Pascal's law to this problem one can see that the amount of force necessary to hold the ring in place will vary with the amount of ring surface exposed to the glass. In pressing an article of this type the throb in the lever caused by the mold filling is not so pronounced as in pressing an article having a narrow flange. This leads to excess pressure often causing the ring to lift slightly and occasionally

permitting a fin to form between the ring and mold on the ring seat. Due to the relative incompressibility of molten glass there is a distinct throb in the lever when the ordinary mold fills. When the presser feels this throb he ceases to pull but holds the plunger in the mold long enough to set the surface of the glass, then releases the lever to throw the plunger out of the mold. In irregularly shaped articles there may be minor throbs or "false fills" that indicate that certain sections of the mold have filled. These often confuse the presser and unless great care is taken the section filling first will be strained. An example of this choking can be had in a deep article having a flange as shown in Fig. 1. It will be easily seen that a sharp increase in pressure is needed to break through the skin at A and continue the flow to the edge of the flange.

In pressing fluted or ribbed articles, glass following the line of least resistance will first reach the ring in the heavier sections and the presser will often have to experiment to find the best way to pull the job to make it fill properly. This is more or less true of all except the very simplest jobs. As the glass flows out over the surface of the mold it does not take the impression of the mold immediately but depends upon back pressure to iron out the wrinkles or ripples. These ripples that have not been ironed out may be seen on the edge of an article that did not fill or on the edges of irregularly shaped articles that fill unevenly.

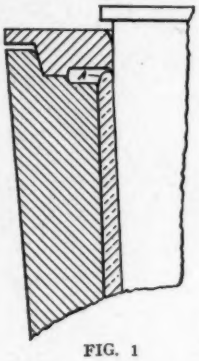


FIG. 1

Blisters are usually considered to be the fault at the gatherer but many of the gatherer's blisters "press out," that is come to the surface and burst during the pressing operation. A mold or plunger having a deep design may trap air which may become enclosed in the glass, usually causing a very large blister. A slower pull may permit the air to escape. In other instances the air will be trapped between the mold and the glass causing a fantail or lap to form as the air escapes. Where the design of the article does not permit the venting of the mold the presser must work to find the best working conditions and devlop his skill to maintain these conditions.

The problem of temperature control can be found in every department of the glass factory. The mold designer and the mold maker study the molds to include all the kinks known to them to assist the presser in making the article for which the mold is intended but the presser must set up and regulate the wind, compressed air and water coolers to get the desired results. Should the presser allow the mold to become too hot the glass may cling to the over-heated section and cause a scar on the mold that can only be removed by repolishing.

Removing the article from the mold requires considerable skill and thought. Sectional molds may be opened and the ware lifted out by means of a fork or pair of pinchers. Common block molds are usually inverted to drop the ware upon a paddle. Very flat articles may be lifted out of the molds by means of a thin instrument. Turntable molds are usually provided with lift-out valves actuated by a foot treadle arrangement. These valves may be very small and are usually struck a few sharp raps to loosen the article in the mold before raising it, as a steady pressure may make an indentation in the article. In some cases equipment is provided to remove the ware from the mold to prevent chipping, scratching or similar damage to special ware. The presser must familiarize himself with all this equipment and see that it is properly used.

A large amount of pressed ware requires an additional operation in the blowing room such as knocking out bottoms of shades or reflectors, putting on handles, finishing, fire-polishing, etc. This work is more or less under the direction of the presser and it is he who is responsible for the equipment. To the presser it is all in the day's work but without a great deal of training and thinking it may be a hard day's work.

Weathering of Special Window Glasses

Over 18 months ago the bureau called attention to the fact that the special window glasses which are used to transmit ultra-violet radiation undergo a greater decrease in transmission when exposed to the mercury arc than when exposed to the sun and that further exposure of these glasses to the sun, after exposure to the mercury lamp, increases the ultra-violet transmission to a higher value than the minimum attained by prolonged exposure only to the sun. This overshooting in transmission, which ranged from 1 to 6 per cent above the minimum attained by exposure only to sunlight, was found in 17 out of 20 samples of different makes of glass, including the most widely known glasses, such as Vita-glass and Helioglass. It was then indicated that a further investigation would be required to determine whether this condition would remain permanent on further exposure to the hot, summer sun. To this end the exposure of these glasses to the sun was continued and their transmissions determined in January and March, 1930.

During the past month further measurements were made on these glasses, showing that this overshooting in transmission is not permanent but increases to a maximum, after which it decreases again to a value that is closely the same as, or somewhat lower than, that attained by exposure only to the sun.

Experiments show that the decrease in transmission, caused by the action of ultra-violet radiation, can be counteracted by maintaining the glass at suitably high temperature. The rejuvenation tests, with sunlight transmitted through filters, show that wave lengths in the region of 365 to 400 $n\mu$ produce the greatest rejuvenation, but sufficient time has not yet elapsed to determine whether this will remain permanent. —*Tech. News Bull.*, Bur. of Stds., Aug., 1930, p. 80.

The Belgian Glass Industry

Conditions in the glass trade in Belgium are depressed, according to a report of Consul William C. Burdett, Brussels, issued by the Department of Commerce, July 7. The output has been reduced to correspond as far as possible with the demand but prices were held firm. The window glass industry is not in such good shape as the plate glass business, suffering, in spite of the reduced production, from a shortage of orders.

Justification of Waste Heat Boilers Continuous Glass Tanks

By JOHN W. ROMIG, M. E.
Corning Glass Works

THE subject of waste heat boilers often arises in industrial plants having furnaces or kilns that discharge large volumes of hot waste gases. Glass plants are no exception but the application of waste heat boilers is not common in the glass industry. In some instances there is considerable doubt as to the economics of a waste heat installation, but in other instances the heat recovery will soon pay the cost of waste heat boilers. All glass plants have some use for steam during winter months while most use steam every month of the year. The operation of gas producers requires a certain amount of steam and where producer gas is used for fuel there is a base steam load regardless of other processes requiring steam.

There are occasional installations of waste heat boilers on glass tanks in this country and on the Continent. Fire tube boilers have had the preference in the United States, but in some European installations the economizer such as is used in connection with super-power plants has been in favor. At least one of the superheater companies has developed a waste heat boiler that incorporates the superheater fin principle in a compact water tube boiler unit. The full possibilities of this equipment have not been realized, but the theory and principles look quite favorable. At any rate there are several makes and styles of heat transfer devices that are quite applicable to waste heat service.

As far as glass tank operation, tank cycles and tank life are concerned, the application of waste heat boilers presents no handicap if the installation has been carefully planned. The continuity of glass tank operation is such that an almost constant supply of waste heat is available for steam generation. Air preheaters have been given study and consideration by some, but proper regenerator or recuperator design allows an air preheat that removes the advantages of air preheaters. If air from air preheaters can be used with tanks not having regeneration or recuperation then the air preheater has an application, providing that the temperatures of waste gases are not too high for the preheaters.

Conditions in glass plants vary widely so it cannot be said that if a waste heat installation is profitable in one plant it will earn its keep in another. The factors involved in the economics are: 1, the amount of heat that is available for diversion through a waste heat boiler and 2, the steam pressure that must be maintained. The amount of heat available depends upon the quantity of fuel burned, the heat reclaiming capacity of regenerators or recuperators, the tank temperature and upon the loss in temperature of the waste products as they pass through the flues to the stack. If the steam pressure is low the steam temperature is correspondingly low and vice versa. Therefore, to recover the most heat a low steam pressure is an important factor, as waste gas temperatures may be reduced almost in proportion to steam temperature as they leave the boiler. Counter flow schemes developed in some boilers give results somewhat comparable to low pressure generation, even when steam is generated at high pressures.

Each tank installation must be considered as a separate problem in working out economics to show whether or not waste heat boilers will give a return on the investment. Data must be collected, computations developed on heat savings, estimates made on installed cost and a balance sheet drawn up to show earnings on the capital invested. The most difficult step is that involving the heat computations so an example will be worked out for a producer gas fired tank. Heat recoveries are developed for varying waste gas temperatures in the case of both low and medium high pressure steam. The producer gas and tank data shall be the same as shown in part II of "Economics of Producer Gas, Fuel Oil and Natural Gas Compared," appearing in the January 1930 issue of THE GLASS INDUSTRY. However, the data directly applicable to the waste heat recovery problem is given below:

B. T. U. in one pound of coal as received.... 14,000
Tons of coal gasified per 24 hrs..... 30
Cubic feet of producer gas per pound of coal.. 72.5

Excess air—50%—corresponding to about 5% oxygen in the waste gases. Waste gas temperatures at point where gases can be diverted into a waste heat boiler—800° F. to 1200° F. for comparisons.

Volume of waste gas products per cubic foot of producer gas:

CO_2	.345 cu. ft.	H_2O	.260 cu. ft.
O_2	.130 cu. ft.	N_2	2.020 cu. ft.

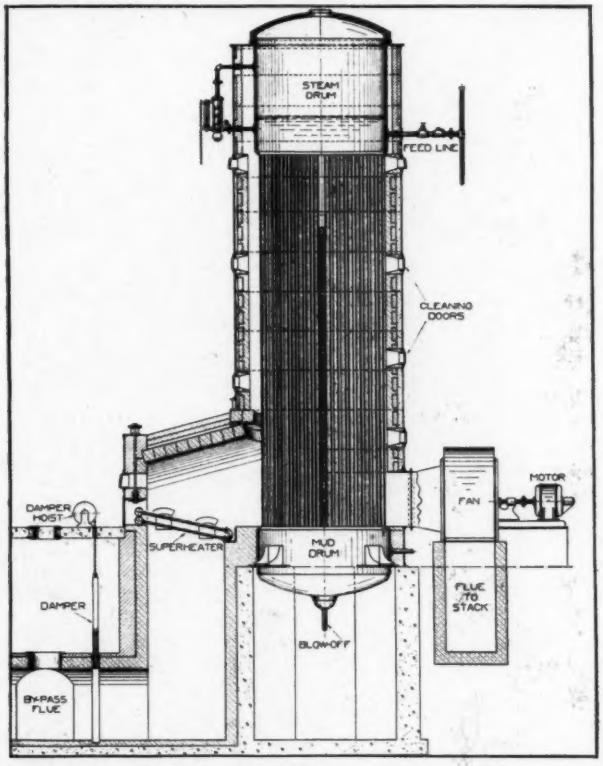
Consideration is given to steam generation at both high and low pressures—a high pressure of 150 pounds gauge is taken as one example and a low pressure of 3 lbs. gauge is taken as another example. It is possible to operate a high pressure boiler and generate low pressure steam during heating months and high pressure steam during the off heating months. However, in the comparisons made, the available heat will be calculated for 150 lbs. gauge or 366° F. steam and for 3 lbs. gauge or 220° F. steam. It is evident that more heat can be taken out of flue gases in the case of the low pressure, low temperature steam as the differential between the waste gas temperature and the steam temperature is 146° F. greater. The use for low pressure steam is not as general as for high pressure steam, its application being in the heating system, hot water heaters, feed water heaters in the boiler room and for low and mixed turbo-generators. A further use for low pressure steam is possible but not fully developed—that is, for gas producers.

The first step in working out the economics is illustrated for a waste gas temperature of 800° F. and is shown in Table I which shows the total heat lost up the stack.

Constituents in Flue Gas	Volume per Cu. Ft. of Gas	Heat Content Per Cu. Ft. Pure Constituents	BTU Above 0° F In Volume of Constituent present
CO_2	.345	23.4	8.10
O_2	.130	14.4	1.87
H_2O	.260	18.2	4.74
N_2	2.020	14.4	29.15
Total heat (BTU) in one cubic foot of waste gas.....			43.86
Total heat (BTU) in flue gases from 1 pound of coal 72.5 x 43.86			31.70

TABLE I

If we could bring the final temperature down to 0° F. a total of 3170 BTU would be available in the flue gas from one pound of coal. However, this is not possible and only a part of the 3170 BTU can be recovered. In the



TYPICAL SETTING OF VERTICAL WATER TUBE BOILER RECEIVING WASTE HEAT FROM OPEN HEARTH FURNACE

first place the steam generated has a temperature corresponding to the pressure—either 220° F. or 366° F. in the cases under consideration. A second handicap to complete recovery is the temperature differential between the steam and the waste gas as it passes from the boiler. A temperature differential must exist for heat transfer to the water in the boiler. The available heat, therefore, is the difference between the heat content of the waste gases as they enter the boiler and the heat content as they leave the boiler. The calculations are made on the basis of 200° F. as the required differential between the temperature of waste gases leaving the boiler and the steam temperature. It is well to consult boiler people in specific applications of waste heat boilers and exit temperatures for their boilers.

The available heat with varying flue gas temperatures is in Table II for three pound and 150 pound steam pressures on the basis of available heat per pound of coal entering the gas producer. Column 3 is determined by subtracting from the total heat in the flue gas the heat in the gas leaving the boiler for three pound steam; that is, the heat in the flue gas at 4200° F.

Column 4 shows the available heats for high pressure steam or a boiler exit temperature of 566° F.

Temperature Waste Gas °F	Heat per lb. Coal above 0° F	Available Heat BTU per lb. of coal above 420° F or 3 lb. steam cut temperature	Available Heat BTU per lb. of coal above 566° F or 150 lb. steam temperature
420	1550	0	..
566	2160	..	0
600	2310	760	150
700	2720	1170	560
800	3170	1620	1010
900	3610	2060	1450
1000	4100	2550	1940
1100	4550	3000	2390
1200	5050	3500	2890

TABLE II

A study of table II shows plainly the advantage of low exit temperature. If a high pressure boiler would allow as low an exit temperature as the low pressure boiler then the heat available as shown in column 3, Table II, would apply to high pressure steam generation.

A part of the available heat is lost in convection, radiation, etc., from a waste heat boiler—such losses may amount to 10 to 25% of the available heat, leaving a net of 75 to 90% of the available heat that is returned in the form of steam. A well designed installation should permit 85% of the available heat to be transferred into steam; in the computations the boilers will be assumed as capable of this performance. Table III below shows the heat absorbed from producer gas waste gases from 30 tons of coal over a period of 24 hours for both high and low pressure steam with varying waste gas temperatures.

Waste Gas Temp °F	3 Lb. Steam Available Heat BTU	Heat Absorbed Million BTU per 24 Hrs.	150 Lb. Steam Available Heat BTU	Heat Absorbed Million BTU per 24 Hrs.
600	760	39.	150.	7.6
700	1170	60.	560.	29.
800	1620	83.	1010.	52.
900	2060	105.	1450.	74.
1000	2550	130.	1940.	99.
1100	3000	153.	2390.	122.
1200	3500	179.	2890.	148.

TABLE III

The heat absorbed (million BTU per 24 hours) as shown in Table III is found by multiplying the product of the available heat and efficiency (85% in this case) by the weight of coal per 24 hours. This step is shown to clarify the

method and to indicate the increase of heat absorption with the higher flue gas temperatures. It is of interest to note that the values for high pressure steam are lower than those for low pressure steam—the ratio between the high pressure and low pressure decreases as the flue gas temperatures increase.

The amount of steam and its value is shown in Table IV for both high and low pressure steam with varying flue gas temperatures. The value on an annual basis is shown for a 300 day year as a glass tank averages about 300 days operation each year. It is evident that tanks operating intermittently throughout the year, savings due to waste heat boilers may be reduced to the point where the installation would not pay even if the return each day should be handsome.

Waste Gas Temp.	Thousand Pounds 3 lb. Steam per 24 Hrs.	Thousand Pounds 3 lb. Steam per 300 day year	Value at at $0.25 per M pounds	Thousand Pounds 150 lb. steam per 24 hrs.	Thousand Pounds 150 lb. steam per 300 day yr.	Value at $0.25 per M Lbs.
600	38.6	11,600	1,450	7.2	2160	540
700	59.4	17,800	2,220	27.6	8300	2,070
800	82.1	24,600	3,180	49.5	14800	3,700
900	104.	31,200	3,900	71.0	21300	5,300
1000	129.	38,700	4,700	94.1	28300	7,100
1100	152.	45,500	5,700	116.	34800	8,700
1200	178.	53,500	6,700	141.	42400	10,600

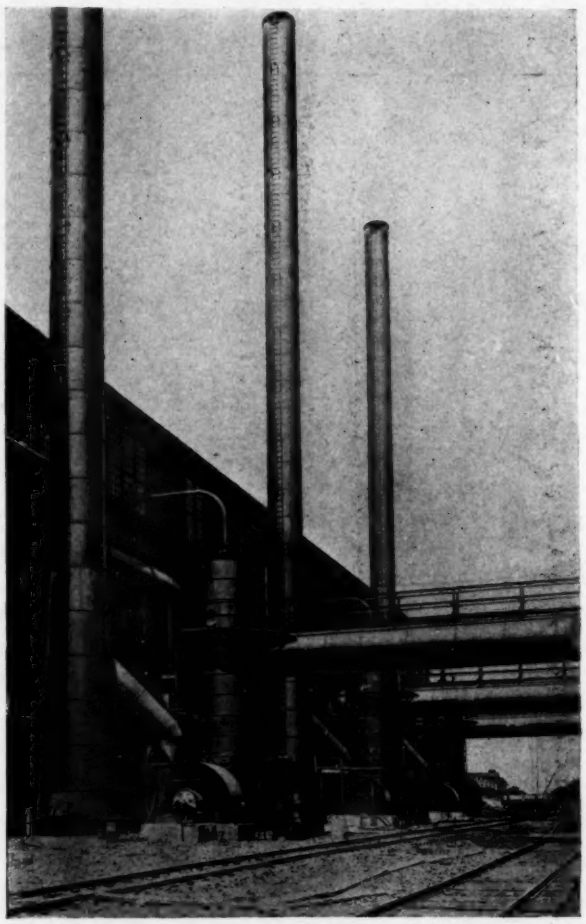
TABLE IV

Having the heat that it is possible to absorb as shown in Table III the next step is to determine how much steam can be generated. It is assumed in the calculation of steam generated that the tank is operating continuously and that the fuel demand is steady throughout the day. This is not quite true but is near enough for all practical purposes. If the water fed into a waste heat boiler passes through a coil in the path of waste gases from a boiler, the water can be heated to 180° F. before entering the boiler proper.

The net heat in one pound of steam at 3 lbs. gauge corrected for 180°F water is 1008 BTU per pound while for 150 lbs. gauge steam the net heat is 1048 BTU per pound. Dividing the heat absorbed by the BTU in one pound of steam the number of pounds of steam is determined. The value of steam in dollars varies in each plant and is dependent upon power equipment, boiler costs and efficiency of operation.

If additional boiler capacity is not needed then the material cost of steam from existing boilers should be used for determination of economics, but if more boiler capacity is needed the total cost (material plus fixed costs) should be used for calculation of the economics. In this particular instance overhead charges are omitted and the material cost of high pressure steam is used in development of the value of a waste heat installation as the material cost represents the only saving.

Low pressure steam admittedly is not as valuable as high pressure steam, for high pressure steam will do work and then be of value as low pressure steam for heating process, etc. Studies of power generating equipment show that with mixed flow turbines, two pounds of low pressure steam are equal to one pound of high pressure steam for power generation. If low pressure steam replaces high pressure steam then its value is considered the same as high pressure steam; this condition exists in the case of a plant generating high pressure steam for factory heating during heating season months. The economics herein are developed on the basis of $0.25 (per 1000 pounds) high pressure steam, material cost only and in the case of low pressure steam the value is taken at $0.125 per 1000 pounds.



A BATTERY OF WASTE HEAT BOILERS RECOVERING HEAT FROM REGENERATIVE FURNACES

The value of the steam as shown in Table IV is not clear profit, as operating and carrying charges must be deducted

from the gross savings. The use of stack draft with waste heat boilers requires a very high and expensive stack and tank control is not as satisfactory with natural draft as with induced draft. Therefore, an induction fan is considered as an essential if tank conditions are to be controlled as desired and at the same time make the most of a waste heat boiler. The capacity of a fan is dependent upon the amount of waste gas to remove and the pressure drop. A satisfactory hook-up is to discharge the induction fan into an existing stack as the power requirements will be reduced by the natural draft of the stack. The capacity of the fan is found for the case taken herein is 17,500 cubic feet per minute. The calculation is

$$\frac{460-566}{520}\left\{\frac{72.5 \times 2.755 \times 60{,}000}{24 \times 60}\right\} \text{ or}$$

maximum *absolute* temperature waste gas leaving boiler times the cubic feet of waste gas from one cubic foot of producer gas from one pound of coal times the pounds of coal per 24 hours divided by the product of the absolute temperature at 60°F and the number of minutes per day. The result is cubic feet per minute. An excess percentage capacity should be allowed as a safety factor. The suction pressure will be around one inch water gauge so the fan should handle about 18,000 cubic feet per minute volume at 1½ to 2 inches water gauge suction plus discharge pressure. About 10 K.W. will be needed so with a power rate of $0.01 per K.W.H. the power cost amounts to $720.00 per year.

The investment taken for this example is $15,000.00 for a waste heat boiler installed. The installation costs vary widely with the makes and styles of boilers and with field conditions.

Debits against savings are:

Depreciation .... $15,000 @ 7½%	$1,125
Interest ..... 15,000 @ 6 %	900
Supplies and Repairs..... 15,000 @ 2 %	300
Power for induced draft	720
Insurance, taxes, etc	155
Total cost per annum	$3,200

Profit from investment in a waste heat boiler depends on boiler steam costs, use for steam, and waste gas temperatures. The profits covering the above discussed installation are developed in Table V for 300 days of operation during one year. The profit or loss is found by subtracting from the steam value the total annual cost ($3,200.00) of the waste heat boiler installation.

Tank Waste Gas Temp.	3 Lbs. Steam @ $0.125 $ Value Steam	Profit or loss $ per annum	3 Lbs. Steam @ $0.25 $ Value Steam	Profit or loss $ per annum	150 Lbs. Steam @ $0.25 $ Value Steam	Profit or loss $ per annum
600	1,450	1,750 Loss	2,900	300 Loss	540	2,660 Loss
700	2,220	980 Loss	4,440	1,240 Loss	2,070	1,130 Loss
800	3,180	20 Loss	6,360	3,160 Profit	3,700	500 Profit
900	3,900	700 Profit	7,800	4,600 Profit	5,300	2,100 Profit
1000	4,700	1,500 Profit	9,400	6,200 Profit	7,100	4,900 Profit
1100	5,700	2,500 Profit Profit	11,400	8,200 Profit Profit	8,700	5,500 Profit Profit
1200	6,700	3,500	13,400	10,200	10,600	7,400

TABLE V

Returns of less than 20% profit on the $15,000.00 investment will not be given consideration because of uncertainties in tank operating schedule, shutdowns, slack periods, emergency repairs, short tank life, etc. An annual profit of $3,000.00 is considered a good return for the investment and for this return under the conditions considered herein waste heat boilers are not justified except as follows:

a. With 3 pound steam applied so that its value is half that of high pressure steam.
   Under this condition a flue gas temperature of less than 1150°F will not permit the installation of waste heat boilers unless additional steam capacity is needed.

b. With 3 pound steam supplanting 25 cent high pressure steam—additional steaming capacity not needed. The investment is not justified unless the waste gas temperature is in excess of 800°F.

c. High pressure steam, additional boiler capacity not needed.
   An investment of $15,000.00 is not justified unless the flue gas temperature is 950°F or higher.
   Should additional steam capacity be required waste heat installations are justified with lower flue gas temperatures. Because of varying conditions each waste heat boiler study must be made for average existing conditions. There are profits to be realized in some plants; in others there would be practically no return on the investment. The example set forth herein gives a method of attacking the problem and the results shown are typical of those expected in the economic justification of waste heat boiler installations. The economics in every instance must be thoroughly analyzed before an intelligent decision can be reached.

Floor Temperatures of Industrial Buildings

Contributions of Modern Glazing to Comfort of Workers

By F. W. PRESTON

IN hot midsummer weather the comfort and efficiency of workers in office and industrial buildings depends partly on the "shade" temperature, which is really the temperature of the air, and partly on the temperature of their more solid surroundings, especially the walls and floor.

This last is often much higher than the air temperature, and the discomfort of workers is not readily assessable by hanging a thermometer in the room, for this reads approximately the "shade" or air temperature, while the distress arises from radiation from the walls and floor, or from merely walking on a hot floor.

The walls of frame buildings can get quite hot, while the temperature of the floor, if exposed to the sun, may be 50° F. hotter than the shade temperature. One has only to lay a hand on the floor to discover how hot even a wooden floor can get.

Office buildings can often be protected in a great measure by pulling down shades or awnings, though at the sacrifice of a certain amount of light. But this is rarely practicable in factories, where the light enters through great areas of glass, and especially through skylights, which cannot always be made to face the north.

Visits to various plants called our attention to the fact that some floors were notably hotter than others, and caused a good deal of distress to the feet. Tired feet are no asset to a manufacturing company, and it occurred to us that it might be well to measure the floor temperature under various conditions, with a view to ascertaining more particularly how far the modern heat-absorbing glasses might assist in reducing the trouble. It seemed to us that the claims made for these glasses could be tested better by comparing floor-temperatures in buildings glazed with heat-absorbing glass with buildings glazed with white glass, rather than by measuring the temperatures of the air in the room by an ordinary thermometer in the shade.

A thermometer in the room is fairly satisfactory in midwinter as an indicator of conditions, for then skylights and windows are closed and ventilation is at a minimum. The air temperature is then a fair guide to the operatives' comfort. But in summer it is quite otherwise. A breeze, as well as the outdoor air, is generally encouraged, and is acceptable, but this is of much the same temperature in all buildings, whereas the comfort varies considerably from building to building in accordance with floor conditions.

A preliminary examination of buildings glazed with heat-absorbing glass as contrasted with buildings glazed, in a more or less similar fashion, with white glass, showed such a superiority in favor of the former that it was thought worth while to experiment a little with controlled conditions, comparing the glass under rigorously identical circumstances.

Some wooden flooring was taken up and samples about 2 feet square were mounted in frames in such a way that they could be kept continually facing the sun, whose rays were to strike them normally (squarely). About a foot above this a pane of glass was supported, so that the sun's rays had to pass through the glass before striking the boarding. Three such frames were prepared, one being "glazed" with heat-absorbing glass, one with white glass, and one was unglazed, to give the temperature of the flooring when exposed to direct sunshine.

Air could circulate freely between the glass above the flooring beneath, so that both the natural convection currents and the slight breezes that were blowing, were free to assist the flooring in cooling to at least as great an extent as in an actual factory.

The temperatures of the flooring were measured by means of a contact thermocouple (iron constantan) which was pressed on the wood and backed with felt. The length of flattened wire in contact with the wood was sufficient to permit the junction to reach the same temperature as the flooring, and the felt, backed by wood, was sufficient insulation to help insure this. The thermo-E. M. F. was measured on a potentiometer, and repeated readings were often identical, and rarely erred by more than the equivalent of 1° F.

Before actually taking the readings, the element was held for 5 seconds on each of five different places on the floor, being moved with minimum delay at the expiracy of each five seconds to a new location. At the sixth location the temperature was read. As a matter of fact equilibrium was reached in 10 seconds, and the remaining 15 were merely formalities.

The same instrument also served to measure the shade or air temperature, and agreed with a mercury thermometer in this detail.

A typical set of readings is given below:

Sun's altitude—63° above horizon.

Sky cloudless, slight haze.

Floor Temperatures

	In Direct Sunshine	Under White Glass	Under Heat-Absorbing glass (American make)	Shade Temperature
	133° F.	122.5	98	85
	136° F.	124	98	86
	137° F.	124.5	98	87
	134.5° F.	125	98	84
Average	135.1	124.0	98	85.5
Difference		(11.1)	26	(12.5)

Difference between sun and shade temperature of flooring 49.6° F. Thus it will be seen that the heat-absorbing glass, which, though slightly colored, does not seem to reduce the illumination perceptibly (being very transparent to the yellow rays), does effect an extraordinary change in the floor temperature. Whereas white glass leaves the lighted floor within a few degrees of sun temperature, the absorbing glass reduces it nearly to shade temperature. The difference between white glass and heat-absorbing glass in this respect proved greater than we expected, and no doubt explains in great measure the relief it affords to the worker.

Relation of Particle Size to the Melting of Feldspar

By A. K. LYLE

FELDSPAR is used in glass as a source of alumina and in recent years has become a quite common batch ingredient. For use in glass the spar is ground to twenty mesh which means that all of it will pass a twenty mesh screen. In most cases approximately fifty per cent of the material will also pass a hundred mesh screen. Probably the only reason for using twenty mesh feldspar in glass batch is that it seems to work satisfactorily but it is altogether possible that a coarser product would be just as good or maybe a finer material better. It is also possible that feldspar of a more nearly uniform mesh would be better than one having the usual wide range of particle sizes.

Following is the report of a preliminary experiment conducted to show the effect of particle size on the rate of melting of feldspar. A standard twenty mesh feldspar was screened into twelve portions.

	Mesh	Percent Retained
1	Thru 20 on 32	.60
2	" 32 on 40	2.50
3	" 40 on 50	4.60
4	" 50 on 60	6.70
5	" 60 on 80	7.20
6	" 80 on 100	9.60
7	" 100 on 120	8.50
8	" 120 on 140	4.00
9	" 140 on 160	8.30
10	" 160 on 200	6.80
11	" 200 on 250	3.70
12	" 250	36.80

A sample of each screened portion as well as a sample of the original unscreened spar was made into a cone by mixing it with a little dextrin solution thus making thirteen cones. These cones were approximately an inch in diameter and an inch high and were mounted on small tiles. When the cones had dried they were placed in a sagger. The sagger was then placed in a furnace, brought to red heat in about twenty minutes and covered. Firing was continued to cone ten. Cone nine dropped in about three and one-half hours and cone ten was down in four. Cone ten drops at about 2,460° F, so that this can be taken as the final temperature. By this treatment the coarsest material (20-32 mesh) was barely sintered while the spar which passed a 250 screen was almost glass. Between these extremes there was a regular procession in the degree of melting which had taken place.

Without the aid of identification marks it was found possible to arrange the samples in the order of their fineness. In five trials by five different judges all of the screened samples were arranged in proper order. The unscreened sample was four times placed in ninth position in order of increasing fineness and once in eighth.

CONES OF FELDSPAR BURNED TO CONE 10. NUMBERS REFER TO THE MESH. THE UNNUMBERED CONE IS THE ORIGINAL UNSCREENED MATERIAL

Calculation of the average mesh of the original sample from the screen analysis shows it would just pass through an 128 mesh screen and that 50 per cent of it would be retained on an 148 mesh screen. The average sized particle in the original sample is therefore somewhat smaller than the screened portion which passed an 120 mesh screen.

Analysis of the data show several interesting results. First: The cone of coarsest feldspar was not melted to the same degree as the next to coarsest cone and so on through the entire series. This shows definitely that a relatively small difference in particle size effects the rate of melting and that the finer the particle the faster the rate will be. Second: The cone made from original unscreened feldspar behaved exactly like a cone made of material slightly finer than the 120-140 mesh cone. Calculations showed it to correspond to a sample which would pass through an 128 mesh screen and be retained on an 148 mesh screen which checks the actual result. It seems evident then that the be-

(*Continued on page 213*)

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Unemployment

THE army of unemployed continues to grow. A recent British estimate has it that there are in the civilized countries of the world about 16,000,000 unemployed. They include two and three quarter millions in Germany, two millions in Great Britain, five or six millions in the United States, three hundred thousand in Australia, and so on. It will be observed that if these figures are correct, the population of unemployed in all these countries is about the same, viz., 5% of the total population, men, women and children.

It will also be observed that the countries suffering from unemployment are essentially the most modernized and efficient ones.

Various explanations have been advanced and there is evidently an element of truth in many of them. The English are apt to blame the growth of tariffs, which restricts overseas trade. The Americans blame the stock market. We do not doubt that both tariffs and stock markets are inventions of the devil, but we do not believe that they are at the root of the matter. Their recent misbehaviors are symptoms of the disease, not the cause of it.

The American people worship money, and they worship work. As the English would say, "it is good form" to be at work, and very good form to make money. It is not inherently or obviously vicious to feel that way, and the feeling that work is good and money desirable has made the United States the leading country of the world. The other progressive countries feel somewhat similarly about it, and Emerson a hundred years ago described the English as a race who reduced all ideas to a monetary level. But the corollaries are not so good. Whatever is produced is produced for the sake of the producer, and not for the consumer, whose interests are consulted only in the enlightened self-interest of the producer. Thus Canada a year ago did not know what to do with its super-abundant wheat crop, and there were lots of Chinese that could have eaten it, but it would cost money and labor to take it to the Chinese, and the Chinese could not pay for it. It was better to let the Chinese go hungry, provided they did not actually starve, or provided at least that we did not hear about their starving.

The plain fact of the matter is, the more efficient countries can produce more than they want for simple, honest, healthy living. Everybody can have enough and to spare, except that the necessity of forcing everything through the bottle neck of a severely restricted money channel results in a great waste of efforts that are otherwise efficient. We can have all the potatoes, pork, and pig iron we can use, and it is not necessary for us to work eight hours a day for forty or fifty years of our lives to ensure it.

Our civilization rests on a queer basis. If the decree went forth tomorrow that nothing shall be consumed till it had been transported at least 5,000 miles, the country would at once become prosperous. Steel girders made in Pittsburgh would have to be shipped to San Francisco and back in order to be used in or near Pittsburgh. Pork slaughtered in Kansas City would make a trip around the States in refrigerator cars. The railroads would become

phenomenally busy, they would wear out their rolling stock and their tracks and be letting contracts for rails and freight cars. Steel mills and wagon works would soon be working overtime, and the overburdening of the railroads would spur all sorts of road traffic to competition. General Motors and Mack Trucks would soon be running sky-high in Wall Street, and everybody would be wearing silk shirts around the glasshouse.

Yet nobody can contend that pork is any the better for a five thousand mile trip, or that unnecessary shifting of goods hither and yon really increase the wealth of the country. The output of steel may go up if the Pennsylvania has to replace its rails twice as often, but in the end there is only the same amount of track, and the rails have been worn out uselessly. Yet we are supposed to gage our country's well being and our soul's happiness by the output of steel or by monthly car-loadings.

To be at work is all right, but most of our work is waste effort, except as a moral discipline. Any glass man can see that it is somewhat futile to set men to work by lung power to blow lamp-bulbs in competition with, or replacement of, the Westlake or Corning 399. And probably the work that goes along with even our most up-to-date machines will seem largely futile and extravagant in a few years' time. We have to get used to the idea that the curse "In the sweat of thy brow shalt thou eat bread" need no longer apply to twenty-four hours—or even eight—a day, or to the uttermost bitter end of our days. Through machinery Paradise is in part regained. We can loaf.

Or at any rate we can take time off for our mental and spiritual development. Nathaniel Hawthorne lost his job, and he was very disconsolate. His wife, wiser than he, had managed to save a few dollars. Hawthorne did not go round looking for a new job. He took time off to write one of the finest books this country has produced—The Scarlet Letter.

In Europe, particularly in England, the progress of science has been very largely in the hands of the unemployed. They call themselves gentlemen, or men of leisure. Lyell and Darwin and Cavendish were of their ranks, and many others like the late Lord Rayleigh never hunted a job.

In the long view, then, unemployment of the present type is not a curse. It will be more or less normal in a society better adjusted in its financial arrangement to our present degree of technical progress. If, under our present social order, we can only reabsorb the unemployed by carrying our pork twice across the continent, it is time we improved our order and found a less wasteful solution.

F. W. P.

The Manufacture of Rolled Plate

IN an early issue of THE GLASS INDUSTRY, we begin the publication of an important work by Herr E. Lutz on the manufacture of rolled plate. This treatise, which will appear in installments over a considerable period, is an authorized English version of a section of the new edition of Dralle-Keppeler, "Die Glasfabrikation," the German edition of which will appear about July of next year. It is our intention to complete the advance publication in this country before that date.

The author of the work is a prominent mechanical and chemical engineer. He was for many years engaged directly in the manufacture of plate glass in Europe, as superintendent and manager of important plants. At the present time he is manager of the Dessauer Zucker-Raffinerie G.mb.H. at Dessau, a firm well known in the United States, and associated with the Dessauer Werke fuer Zucker und Chemische Industrie A.G. This concern is working up molasses through which are obtained, among other things, potash, soda, and salt cake of a quality specially suited for the better sorts of glass.

Herr Lutz is well known in the United States, through which he has made prolonged journeys, and we are glad to be able to present this treatise of his to our readers. In it will be found a great many valuable suggestions on the operation of pot furnaces, and of rolling equipment. Much of this information concerns fundamental matters, which are applicable, mutatis mutandis, not only to the equipment described, but to the newer forms of apparatus which are continually appearing in this era of change and turmoil. A diligent study of some of these matters would have saved a good deal of money to American manufacturers in the last few years, and we hope that it will save them a good deal in the years ahead.

Relation of Particle Size to the Melting of Feldspar

(*Continued from page* 211)

havior of feldspar in melting is determined by the average size of the particles and not by the size of the coarsest particles. From this we can predict that a feldspar all of which would pass a 50 mesh screen and have 50 per cent pass through a 150 mesh screen, would behave exactly like the feldspar used in this test which had almost 8 per cent retained on a 50 mesh screen. It is also possible that a spar containing a larger proportion of material that would be retained on a 32 mesh screen, providing 50 per cent would pass an 150 mesh screen, would be identical in its behavior.

The results of this test show nothing definite regarding the behavior of feldspar in glass but they do indicate the possibility of positive results in a continued investigation with actual glass melts.

The feldspar used in this test was from the North State Feldspar Company who fired the cones.

The Laboratory

Fluoride Interference in R^2O^3 Determinations

By S. R. SCHOLES[1]

When a glass sample has been decomposed by evaporation with hydrofluoric acid, erratic results are sometimes obtained in the estimation of iron oxide and alumina. It is essential that an excess of sulphuric acid, over the amount

[1] Fostoria Glass Company, Moundsville, W. Va.

necessary to combine with the bases, be present, also that the evaporation be completed over a flame until the dense fumes of sulphuric acid can be certainly recognized.

After the water-bath evaporation of the sulphuric-hydrofluoric acid mixture with the glass sample, when it appears that no more hydrofluoric acid can be driven off, this further heating at a higher temperature will cause a distinct effervescence. When this has ceased, and dense white fumes rise from the crucible or dish one may be sure of complete removal of fluorine.

The interference of fluorine may be explained, in the writer's opinion, by the formation of a complex ion such as—AlF_6''' or—FeF_6'''. Such an ion would be analogous to —$Fe(CN)_6'''$ in the ferri-cyanides. The mineral cryolite, in this view, may be considered as the sodium salt of a hypothetical "alumino-fluoric acid," which could be represented as H_3AlF_6.

"Double salts" have been described, such as $3NaF.AlF_3$, and $3NaF.FeF_3$. But it is just as reasonable to suppose that the complex ion forms, especially since the usual ionic reactions of aluminum and iron fail to appear.

For example, the presence of a few drops of hydrofluoric acid in a Nessler tube is sufficient to suppress the development of the thiocyanate color in testing for ferric iron. This recalls the similar behavior of iron combined as ferricyanide. Likewise, only a part of the alumina in a solution containing fluorides can be precipitated by ammonia.

An interesting synthesis of the salt Na_3FeF_6 can be carried out by bringing together the chlorides of sodium and iron in hydrofluoric acid, and warming. Upon cooling, needles separate, which upon analysis are found to have the above composition. A similar salt can be formed, with aluminum in place of iron.

These reactions are of interest, not only for the chemistry involved, but because they reveal an obscure source of error in the analysis of a glass or in the testing of sand or feldspar for iron by colorimetric methods.

New Tariff Investigation of Window Glass Ordered

Public Notice of Investigation by the United States Tariff Commission under the Provisions of Section 336 of Title III of the Tariff Act of 1930.

INVESTIGATION NO. 20 BY THE UNITED STATES TARIFF COMMISSION FOR THE PURPOSES OF SECTION 336 OF THE TARIFF ACT OF 1930 WINDOW GLASS

The United States Tariff Commission on this 14th day of August, 1930, under and by virtue of the powers granted by law and pursuant to the rules and regulations of the Commission, and in accordance with Senate Resolution No. 313, 71st Congress, 2d Session, hereby approves the following form of order of the investigation voted on July 11, 1930, for the purposes of Section 336 of Title III of the Tariff Act of 1930, of the differences in costs of production of, and of all other facts and conditions enumerated in said section with respect to, the article described in paragraph 219 of Title I of said tariff act: namely,

Cylinder, crown, and sheet glass, by whatever process made, and for whatever purpose used,

being wholly or in part the growth or product of the United States, and of and with respect to like or similar articles wholly or in part the growth or product of competing foreign countries.

Ordered further, that all parties interested shall be given opportunity to be present, to produce evidence, and to be heard at a public hearing in said investigation to be held at the office of the Commission in Washington, D. C., or at such other place or places as the Commission may designate, on a date hereafter to be fixed, of which said public hearing prior public notice shall be given by posting the notice thereof for thirty days at the office of the Commission in the City of Washington, D. C., and at the office of the Commission at the Port of New York and by publication once each week for two successive weeks in "Treasury Decisions" published by the Department of the Treasury, and in "Commerce Reports" published by the Department of Commerce, copies of which said publications are obtainable from the Superintendent of Documents of the Government Printing Office in Washington, D. C.

And ordered further, that public notice of said investigation shall be given by posting a copy of this order for thirty days at the principal office of the Commission in the City of Washington, D. C., and at the office of the Commission at the Port of New York, and by publishing a copy of this order once a week for two successive weeks in said "Treasury Decisions" and in said "Commerce Reports."

I certify that the foregoing is a true copy of an order of the United States Tariff Commission passed on the 14th day of August, 1930.

JOHN F. BETHUNE,
Secretary.

Where We Stand Compared With Others

The Bureau of the Census, W. M. Steuart, director, U. S. Department of Commerce, at Washington, recently issued a 56 page pamphlet entitled "Summary by Industry Groups and by Industries 1927." Tables show how the glass manufacturing industry ranks, in several respects, in comparison with 96 other miscellaneous industries, each unit of which manufactured products during the year 1927, valued at $100,000,000 or over.

In the number of wage earners employed, the glass industry ranked twenty-seventh. A total of 71,533 persons were engaged in glass making in 269 factories. This number comprised 79 proprietors and firm members, 5,629 salaried officers and employes and 65,825 wage earners (average for the year). Salaries and wages totalled $95,206,516—salaries $13,853,782 and wages $81,352,734.

The amount spent by the glass factories for supplies and materials, product-shipping containers, fuel and power, in 1927 was $109,911,000 and in this respect the industry took rank as the sixtieth in importance. Products valued at $282,394,000 were manufactured, making the rank on this item the fiftieth in the list. The value reported as added to the raw materials by manufacturing processes was $172,483,000, ranking thirty-seventh in importance among all the industries compared.

It is noticeable that in the census year 1927, the total cost of wages was exceeded by the cost of materials, supplies, fuel power, etc., to the extent of about 25 per cent. This situation has been brought about, no doubt, but the tremendous reduction in labor costs due to the utilization of automatic and semi-automatic glass making machinery.

It may be recalled by the old-timers that twenty-six years ago, in the period beginning 1904, just when the present era of mechanical production was opening up, 399 glass plants, the largest number ever in operation at one time, expended for glass making materials, etc., that year about $26,000,000. Salaries and wages amounted to over $41,000,000, or over 50 per cent above the cost of materials—quite a different ratio to that prevailing now.

The same table gives the following figures for clay products (other than pottery and non-clay refractories): Number of establishments 1,846, number of wage earners (average for year) 100,972, rank 19; cost of materials supplies, containers for products, fuel and power, $99,870,000, rank 62; value of products $319,908,000, rank 41; value added by manufacture $220,038,000, rank 25. The persons engaged in the clay products industry (other than pottery and non-clay refractories) numbered 109,983; proprietors and firm members, 600; salaried officers and employes, 8,441; salaries and wages totalled $143,836,202 as follows: salaries $21,868,695, wages $121,967,507.

Granular Glasspar

Discussing the uses of granular glasspar, B. C. Burgess, manager of the Tennessee Mineral Products Corporation Plant at Spruce Pine, N. C. writes as follows:

"Granular glasspar is an innovation in the feldspar business. It is made particularly for the glass manufacturer and is made granular so as to conform with the other granular materials that the glass man uses."

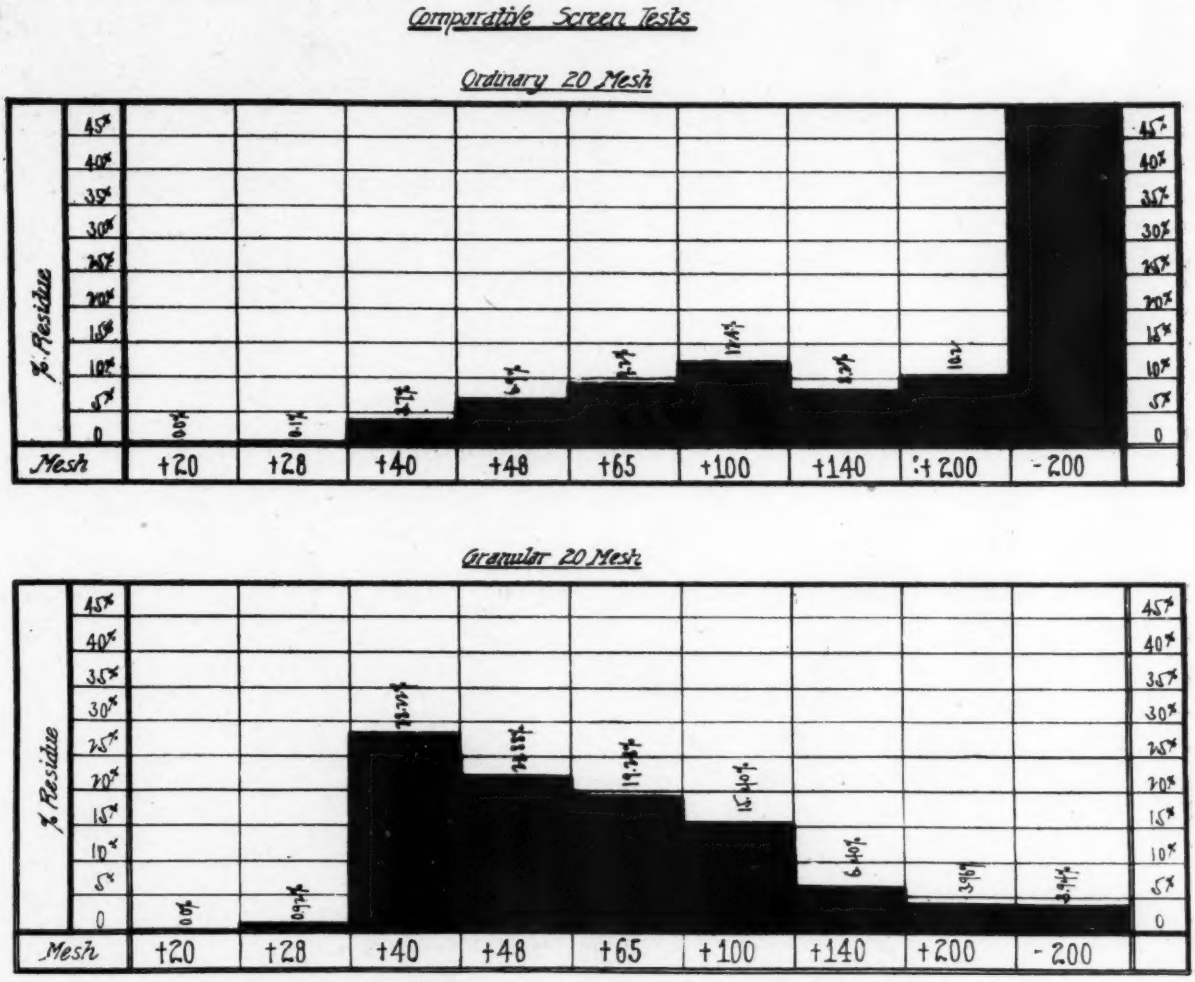
"'We want feldspar all through twenty mesh and all on one hundred mesh.' How many times have glass manufacturers told us that? We can't count them but we do know that these requests are becoming much more frequent and universal.

"In reply we have explained that with the present grinding process we would have to grind *three* tons of material to produce one ton of this product. We would then be left with the *two or more* tons of through one-hundred mesh spar to dispose of. The consumers of minus 100 mesh spar use only a fraction of the tonnage used by glassmakers. The sale of this product would be further limited by its analysis. The production of a granular product with present grinding equipment was therefore impossible."

"Knowing" says Mr. Burgess, "that when customers begin to show a general desire for an improved product, someone is going to produce it for them," his company therefore went to work and developed a new process which makes only one-tenth of the fines made by the present process.

There was one objection to this process, and a very serious one: it could not be used without increasing the iron content of the spar. As feldspar producers were already having trouble holding the iron content within limits this again seemed an impossible barrier.

The problem was not simply one of removing the metallic iron. The installation of a separate unit for the new process would be very costly. To warrant this expenditure the process must go a step further and lower the original iron content as well as make a total extraction of iron added in the process.



GRAPH ILLUSTRATING COMPARISON OF THE SCREEN TESTS OF OLD AND NEW GRADING

Tests were made on practically all the types of concentrating equipment known, including dry and wet tables, magnetic and electro-static separators. None of these were entirely satisfactory. Finally, a small induction separator was located which appeared to have possibilities and a much more powerful machine was built particularly adaptable to the separation of spar.

Results of test runs on the new machine were remarkable. It not only removed the magnetic and feebly magnetic minerals but it separated particles such as muscovite mica from the spar.

Arrangements were made for the exclusive use of this separator in the feldspar industry. Plans were made for a separate unit at Minpro, N. C., incorporating the new grinding process and the induction separator.

The unit is being rushed to completion, which the illustrations show and it is expected that it will be in production by the time this article is in print. It takes its product from the present flow sheet just beyond the dryer. Surge bins are provided ahead of the

unit for flexibility. Double deck screens are used to scalp off mica and to return oversize. The product remains in circuit until it is all through twenty mesh. The material is then elevated to a screen. This screen classifies this into two sizes. Surge bins feed these sizes to the magnetic separator. The separator product is automatically sampled and stored in mixing bins. Blends are made from these bins by the same process of chemical control that now characterizes all the company's products.

Perhaps the most noticeable property of granular glasspar is its free-flowing dustless nature, similar to glass sand. The reason for this will be readily apparent by comparison of the screen tests of the new and old grindings, which the accompanying graphs plainly show.

It is believed, however, the low iron content will be a more valuable contribution to the industry. Without induction separation, it has been difficult for producers to maintain a .10 Fe_2O_3 maximum. In spite of all they can do, carloads will occasionally get out running .12% or even .13%. The iron analyses from the commercial tests run on the induction separator were from .05% to .063%. It takes out practically every speck of contaminating mineral visible in the spar.

According to Mr. Burgess, glass manufacturers who have examined the new product have found it to possess the following characteristics:

Enters the batch mix more evenly and perfectly.

When used with other granular ingredients, lessens batch separation.

A quicker and more uniform melt.

Requires less heat, reduces melting time and lowers production cost.

Flows more freely to batch mixer.

Prevents clogging of checkers.

Dustless in unloading, weighing and mixing.

Lower and more uniform in iron content.

The process so far is to be used primarily for production of granular glasspar but its application to other grindings is apparent and the company will proceed to develop these immediately following completion of the present program.

Tennessee Mineral Products Corporation, controlled and operated by the United Feldspar Corporation, are the producers of the granular type of glassmakers' feldspar described above which will be marketed through the company's sole sales agents, The Roessler & Hasslacher Chemical Company, 10 East 40th Street, New York.

PLANT AT SPRUCE PINE, N. C., SHOWN UNDER CONSTRUCTION. RECENTLY COMPLETED AND NOW READY FOR OPERATION

More Scope for Technical Men in Europe

Dr. W. C. Taylor, chief chemist of the Corning Glass Works, who returned a short time ago from a trip abroad which began at New York on May 9, has responded to an editorial suggestion that he favor his many friends with an account of his recent visits to various British and Continental glass plants and tell them something of the more interesting developments he observed while there, by explaining the impossibility of doing so, most of his activities having been related to confidential matters. He writes, however, as follows:

W. C. TAYLOR

To the Editor of THE GLASS INDUSTRY:

In reference to the notices on my European trip I find that that there is not a great deal which I can report on for THE GLASS INDUSTRY, as most of my observations were made on work of our licensees with particular reference to those things which were of interest to Corning.

I found a better spirit of cooperation among European manufacturers than I had expected with a growing tendency towards greater freedom in the passing along of information of general interest. I was surprised at the size and strength of the glass societies in Europe and the great interest in research work. Practically all plants, however small, had a laboratory and some technical control. All of the larger organizations had well organized research laboratories which I believe exceed in size those in this country.

There is also considerable interest in engineering developments and although European glass manufacturers have been somewhat slow in going to machine production this has been due in most cases to the limited output which did not warrant machinery rather than to an unwillingness to change old methods. In such plants where machine production could be used to advantage I found the methods used were quite efficient and up-to-date. In fact the European engineers are rapidly proceeding to develop machines of their own. Several of these, especially some designed for tubing manufacture, were called to my attention. While the first move in machine development was to obtain machines developed in America, I think in the future we will see many machines developed on the other side although these may be particularly adapted to European needs rather than to the larger output of American plants.

CORNING GLASS WORKS — W. C. TAYLOR
Corning, N. Y. — *Chief Chemist*
August 5, 1930.

Swedish Glass Makers Unite

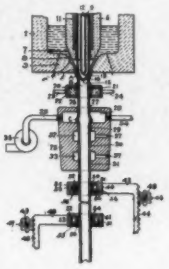
Fifteen of the largest manufacturers of household and ornamental glassware in Sweden have formed an export cartel for the purpose of promoting the sale of the members' products in certain export markets. Attention is now being centered on the English market. An agreement has been made with a group of importers in London which stipulates that the latter will purchase from the association only. The Swedish producers on their part agree not to sell to any other English importer.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

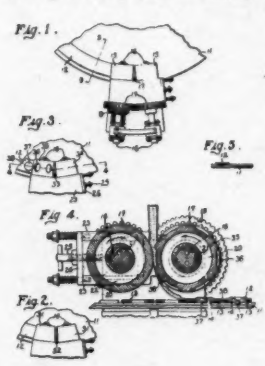
Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

DRAWING GLASS TUBING. U. S. 1,766,638. June 24, 1930. George E. Howard, Butler, Pa., assignor to Hartford-Empire Company. Filed 5/28/23. The invention has special reference to the drawing of tubes from glass having low heat-expansion, high melting temperature and long range of plasticity, such, for example, as the borosilicate heat-resisting glasses of the "Pyrex" type.



The inventor produces glass tubing continuously by causing an annular stream of glass to issue from a receptacle through a downwardly opening outlet which determines the outer diameter of the issuing glass, cooling the outer and inner surfaces of the glass at a regulated rate as it emerges from the outlet, and passing the glass through a former which shapes the glass into a tube of approximately the desired outside dimension and further cools the outer surface of the tube. Then, after a reheating interval, during which the chilled surfaces of the glass are equalized in temperature by heat transmitted from the hotter interior portions of the walls of the tube, the tube is passed downwardly through a sizer which is arranged to bring the tube, while the glass is still plastic, to its final correct size, and finally the tube is engaged by drawing implements which assist the action of gravity in drawing the tube downward. The tube is thus passed through the several shaping mechanisms by the combined action of gravity and the downward pull exerted by the drawing implements.

GLASS-RIBBON-FEEDING APPARATUS AND METHOD. U. S. 1,766,680. June 24, 1930. Sidney F. Parham, West Hartford, Conn., assignor to Hartford-Empire Company. Filed 7/31/28. See U. S. patent application of Robert W. Canfield, filed March 21, 1927, Serial No. 176,988. When as in the manufacture of glass bulbs a ribbon of uniform thickness is fed to a rotating carrier, the tendency is for the outside of the ribbon to stretch and possibly for the inner edge to be compressed, thus resulting in a ribbon with different thicknesses in its outer and inner portions. One object of the present invention is to provide a ribbon that will have a uniform thickness from one edge to the other after it has been deposited on the carrier; also to produce a ribbon of uniform thickness, but longer at one edge than at the other edge before it is deposited in an arcuate path so that such ribbon will naturally tend to assume the desired arcuate form before it is constrained to take such form by being deposited on a rotating carrier or otherwise.

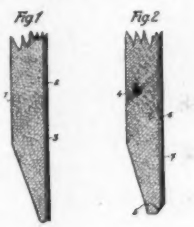


The non-parallel disposition of the adjacent surfaces of the rolls 15 permits a wedge shaped ribbon of glass 17 to pass therebetween. By properly selecting the degree of convergence of the axes of the two shafts 16, the extra thickness of the ribbon at the edge away from the center of the rotating table 11 may be such that the stretching action which results from its conformity to the arcuate path will just reduce the thickness of the outer portion of the ribbon to that of the inner portion, and consequently, a ribbon of uniform thickness will be obtained as shown in section in Fig. 5.

APPARATUS FOR CONVEYING GLASS FROM FORMING DEVICES. U. S. 1,767,913, June 24, 1930. Louis Boudin, St. Gobain, France, assignor to Societe Anonyme des Manufactures des Glaces & Produits Chimiques de Saint-Gobain Chauny & Cirey, Paris, France. Filed 10/20/27. Designed to eliminate the following disadvantage of the present method: The slightest roughness or inequality in the upper surface of the refractory elements of the table is imparted to the lower surface of the still plastic glass sheets. The lower surfaces of the sheet are not smooth, but dull and more or less rough.

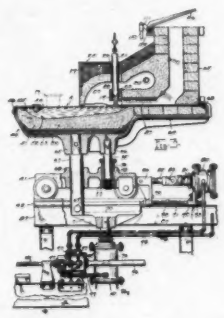
Inequalities in the level of the glass sheets, which frequently cause breakage during transport and use. In impressed glass the design is dimmed or distorted by reason of the contact of the glass plates with the refractory material, and in some cases counter-reliefs are formed on the non-imprinted surface of the plates. Operation of the tables and frequent repairs necessary for the (refractory) covering are the cause of great expense. Space occupied by the apparatus behind the rolling machine at the beginning of each operation is an inconvenience in glass rolling plants.

COATED GLASS PLATE. U. S. 1,766,509. June 24, 1930. Carl Grambach, Zurich, Switzerland. Filed 7/12/27. Fig. 1 shows a silver-coated glass plate as now manufactured. Both coatings extend to the outer margin of the plate. Thus humidity deposited on the rear face of the mirror will collect at the lower margin thereof where it tends to loosen the silver-coating from the glass. Further, by non-uniform expansion by heat of the protective layer 3 and the silver-coating 2, the said silver-coating is made loose more particularly at its margin.



The inventor's improved silvercoated glass plate consists of a plate 4 having at its rear side a bezeled margin 5, a silver-coating 6 applied to the plane part of the rear face of the glass up to the line of intersection of the plane rear face and the bezeled margin 5, and a protective layer of 7 of lacquer or the like covering the rear face of the silver-coating and the bezeled margin 5 of the glass plate. Thus the protective layer sticks to the bezeled margin of the glass plate, and it encloses the silver-coating 6 not only at the rear face thereof, but also at the margin thereof. Preferably, the bezeled margin 5 is made rough by suitable means, so that the protective layer firmly sticks thereto.

GLASS-WORKING TANK. U. S. 1,771,864. July 29, 1930. Leonard D. Soubier of Toledo, O., assignor to Owens-Illinois Glass Company. Filed 1/28/27. In combination, a stationary suction mold, a hood including heating means spaced horizontally from said mold, a tank to contain molten glass arranged beneath said hood and mold, means constantly supplying fresh glass to the tank, means for reciprocating said tank to periodically expose a portion of the glass surface to the atmosphere, and means operating in timed relation with the tank reciprocating means to elevate the tank and bring the glass into charge gathering engagement with the mold. Figure shows the tank in its outermost position, exposing the gathering area so that a charge or charges may be gathered by a mold.



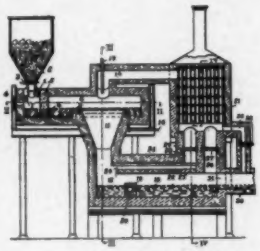
PROCESS FOR PREVENTING WEATHERING OF GLASS. U. S. 1,760,427. May 27, 1930. Robert C. Matlock, Jr., Bloomfield, N. J., assignor to Westinghouse Lamp Company. Filed 10/17/28. One object of this invention is to substantially prevent or to effectually retard the deterioration in the strength of fluoride etched glassware, such as incandescent lamp bulbs, upon exposure to the atmosphere.

The inventor has found that the so-called "weathering" action resulting in loss of strength in glassware superficially etched by

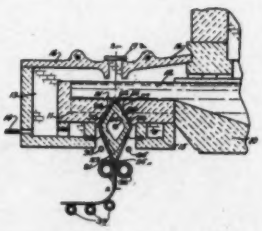
the fluoride process is caused by the absorption of moisture and carbon oxides from the atmosphere by the etched surfaces. By hydrolysis and progressive reaction between the etched surfaces and the absorbed gases, a condition is promoted which results in a noticeable weakening of the glass, particularly after heating as in the sealing in and exhaust operations in the manufacture of incandescent lamps.

The inventor found that excessive and increased concentrations of moisture and carbon oxides in the atmosphere accelerate the so called weathering effect of such etched surfaces and articles and has further determined that if he substantially removes from the frosted surface of the glass the bulk of the relatively insoluble sodium silico fluoride (Na_2SiF_6) compound formed during the etching reaction or the double alkaline and alkaline earth metal silico fluoride compounds similarly formed which compounds have not heretofore been removed by prior washing methods, he may substantially eliminate or materially retard this "weathering" action upon the glass surfaces and consequent loss in mechanical strength and elasticity.

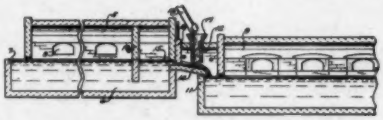
APPARATUS FOR MELTING GLASS AND THE LIKE. U. S. 1,760,371. May 27, 1930. William A. Morton, Pittsburgh, Pa., assignor to Amco Incorporated, Pittsburgh, Pa. Filed 11/19/26. For controlling the temperature in the plaining zone the combination of a plurality of chambers which are atmospherically isolated, one of said chambers being a reducing chamber into which the materials are introduced and another of said chambers being an ebullition chamber, said chambers having a submerged connection between them, a circular weir in the ebullition chamber, said weir being surrounded by the molten glass in said ebullition chamber, a vertical passage into which the glass overflows the weir and travels therethrough in the form of an extended sheet, a working chamber into which the glass travels from said passage, means for applying supermelting temperatures to the glass in said passage, and means for heating the working chamber by waste heat from said passage.



METHOD AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,759,229. May 20, 1930. John L. Drake, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 2/1/28. Sheet glass apparatus including in combination, a working receptacle provided with an elongated slot in its bottom, said slot being longitudinally shaped to provide a relatively freer flow of molten glass through its end portions than through its center portion and a flow slab extending into said slot and co-operating therewith to direct the molten glass into two streams which unite therebelow into a single stream.

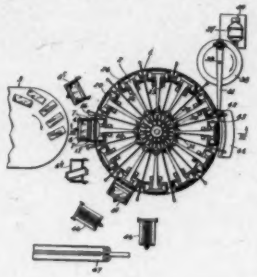


PROCESS AND APPARATUS FOR PRODUCING MOLTEN GLASS. U. S. 1,759,228. May 20, 1930. John L. Drake, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 7/23/27. A specific object of the invention is the provision of a tank furnace installation wherein an auxiliary melting tank is associated with the melting tank of a customary tank furnace, molten glass being produced within the auxiliary melting tank and then caused to flow therefrom into the melting tank of the furnace, additional batch being added to the molten glass as it flows from one tank into the other and means being preferably provided for preheating the additional batch added to the end that the glass making materials may be reduced to a molten state in a more rapid and efficient manner than heretofore.

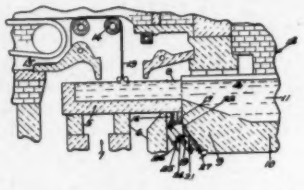


GLASS BLOWING MACHINE. U. S. 1,761,665. June 3, 1930. Hans Hillmann, Dresden-Strehlen, Germany, assignor to the Hillman Syndicate, Limited, London, England. Filed 6/10/29. In a divided blank mold, for a glass-blowing machine, having passages disposed in the divisional planes, the combination of means providing a common suction and blowing space communicating with said passages and the mold cavity, and automatically acting valves disposed between said passages of said space.

APPARATUS FOR MAKING COMPOSITE GLASS. U. S. 1,765,829. June 24, 1930. John H. Fox and William Owen, Pittsburgh, Pa., assignors to Pittsburgh Plate Glass Company. Original application filed 12/17/26. Divided and this application filed 8/1/28. Constituting a division of application, Serial No. 155,424, filed Dec. 17, 1926. Provision of a means and procedure whereby a plurality of composite plates may be formed simultaneously, and whereby quantity production may be secured with a limited number of operatives.



GLASS TANK FURNACE. U. S. 1,761,190. June 3, 1930. Wilbur F. Brown, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 2/3/27. The inventors' claim include a glass tank furnace adapted to contain a mass of molten glass and including a cooling chamber, a draw-pot abutting said cooling chamber, means arranged at the juncture of said draw-pot and cooling chamber for preventing the molten glass from leaking from the furnace at this point, and means for moving said first named means vertically and horizontally to force the same against said draw-pot and cooling chamber.



SHEET-GLASS APPARATUS. U. S. 1,753,766. Apr. 8, 1930. Mike Zadorozny, Charleston, W. Va., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 2/1/28. An invention to provide in sheet glass apparatus, a lip tile formed with a plurality of lips to thereby more effectively protect the sheet from the heat currents and radiated heat.

SHEET GLASS APPARATUS. U. S. 1,761,763. June 3, 1930. Jesse W. Wildermuth, Lancaster, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 10/4/26. A heat-absorbing member comprising a casing, means for introducing a cooling medium therein, an outlet, and means arranged within the casing for directing the incoming cooling medium along one wall thereof, and the outgoing medium along another wall thereof.

GLASS FEEDER. U. S. 1,759,209. May 20, 1930. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 10/26/27.

APPARATUS FOR CLEANING GLASS-POLISHING PADS. U. S. 1,759,820. May 20, 1930. Harold M. Black, Butler, Pa., assignor to Hartford-Empire Company, Hartford, Conn. Filed 5/4/27. A cleaning device for polishing pads, comprising a table capable of traveling movement past a polishing pad in advance of a glass carrying table, a pad cleaning member on said table positioned to engage the polishing pad while traveling, and a guide plate at the rear end of said table whose forward edge extends to a plane below the plane of the succeeding glass-carrying table and whose rear edge is disposed in approximately the plane of said glass-carrying table.

SHEET GLASS SURFACING TABLE. U. S. 1,761,720. June 3, 1930. John C. Gipe, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 6/24/25. In sheet glass surfacing apparatus a table having a sheet receiving recess therein, and a pad loosely mounted within the recess for freely supporting the sheet of glass to be surfaced, said recess being of a shape to prevent turning of the pad and sheet therein.

The Glass World and What It Is Doing

News of the Industry

New Laminated Glass Developments

Several of the manufacturers of clear laminated glass for automobiles and other uses have turned their attention to the production of sheets of this material decorated by the method of coloring the plastic layer which holds the two sheets of glass together. This plastic in safety glass, for instance, is the element that causes it to resist scattering when it meets with a blow or shock from any source. It is said that there is no limit to the number of color or color combinations that can be produced. The Triplex Safety Glass Company of North America, Inc., have named two of these products Artriplex and Ad-Triplex; the Duplate Corporation, Creighton, Pa., term their product the Decorative Duplate; the American Window Glass Company, Pittsburgh, Pa., has adopted the name of Tintaglass for their new product. The different processes that have been developed make possible an apparently unlimited number of effects and the product is finding uses for almost innumerable purposes wherever a hard, smooth, colored surface is required. Pictures and designs of almost every type can be reproduced in the plastic substance. It seems certain that this new development will lead to a substantial increase in the use of glass for purposes to which clear glass has not heretofore been adapted and which have therefore frequently been made up from other materials.

American Ceramic Congress and Exposition

Announcement was made a short time ago by Ross C. Purdy, executive secretary of the American Ceramic Society, of the names of Division Officers and various headquarters for the American Ceramic Congress and Exposition to be held in Cleveland next February 23-27. Headquarters for the Enamel and Glass Divisions will be at the Hotel Hollenden, only a short distance from the Public Auditorium. The Refractories Division and Heavy Clay Products will be at the Hotel Cleveland. The Art, Terra Cotta and White Ware Divisions will meet at the Hotel Statler. Division officers of the Society are as follows:

Art Division. Chairman: E. deF. Curtis, Conestoga Pottery, Wayne, Pa.; Secretary: Mrs. M. M. French, Art Institute of Chicago, Chicago, Ill.; Chr. Program Committee: Prof. Marion L. Fosdick, Alfred University, Alfred, N. Y.

Glass Division. Chairman: Dr. J. T. Littleton, Corning Glass Works, Corning, N. Y.; Secretary: F. C. Flint, 303 S. Main St., Washington, Pa.; Chr. Program Committee: Dr. S. R. Scholes, Fostoria Glass Co., Moundsville, W. Va.

Refractories Division. Chairman: C. F. Geiger, The Carborundum Co., Perth Amboy, N. J.; Secretary: Miss Dorothy A. Texter, Oliver Bldg., Pittsburgh, Pa.; Chr. Program Committee: R. B. Gilmore, 1851 Lampson Rd., Cleveland, Ohio.

Numerous Plants Resume Operations

Among the plants which have resumed manufacturing operations after being closed down for various periods from one to several weeks is the Foster-Forbes Glass Company, Marion, Ind. According to J. M. Foster about 200 employes have returned to work. The D. C. Jenkins Glass Plant at Arcadia, Ind., resumed operations late in July with about 300 men on the payroll after being closed down for some time. Pittsburgh Plate Glass Company, No. 1 plant at Creighton, Pa., resumed operations rather unexpectedly on July 30, earlier than had been anticipated. About 400 workmen went back to the plant. The Oil City Glass Bottle Company, Oil City, Pa., has been expected to resume operations during the latter part of August. H. C. Fry Glass Company put their Beaver Valley Division plant back into operation early in August after a shutdown for inventory and repairs. The United Lamp Chimney Company, Hurricane, W. Va., operated by T. A. & George Nilan, has resumed operations after a shutdown of several weeks' duration. The Pennsylvania Bottle Company's plant at Sheffield, Pa., is another plant which has resumed operations recently after a forced shutdown due to a leaking melting tank.

Professor Turner Visits Switzerland

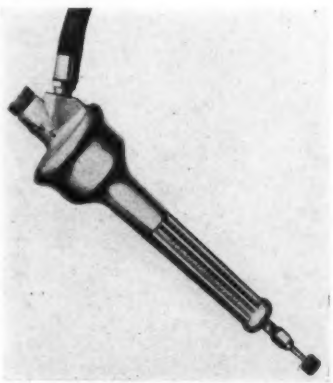
Professor W. E. S. Turner, England's famous glass technologist, left his home at Sheffield, England, on August 9 for a visit to Switzerland in the hope that the sunshine there would bring about complete recuperation from his recent illness and operation.

Belgian Glass Sales Syndicate Dissolved

The Belgian Window Glass Sales Syndicate, according to a report from Brussels, was dissolved on August 2 due to the refusal of the Lodelinsart works, whose annual production is said to exceed one-half million square yards, to line up with it. The Syndicate, which proposed to reduce export prices as a counter balance to the new American tariffs, was of the opinion that its efforts were valueless without complete agreement throughout the trade.

High Speed Air-Grinder

A new high speed air-grinder, the Kipp, recently introduced to the glass trade by H. L. Dixon Company, Pittsburgh, Pa., has a spindle speed in excess of 40,000 revolutions per minute and is adapted for use with grinding wheels of very small sizes. Even a wheel less than an inch in diameter can, it is claimed, be driven at sufficiently high speed for efficient operation. The wheels may be of various forms to suit the kind of surfaces to be ground, and the same is true of polishing wheels, which may be used for smoothing ground surfaces. This device is designed to fit the hand and its length is 8½ inches. It weighs 12 ounces. To insure satisfactory operation of the spindle, rotating at 140,000 R.P.M. there is a ball-bearing provided with seals that retain a sufficient supply of lubricant to last for six months operation. It is stated that this tool has always found great favor in glasshouses both for grinding the edges of glass sheets, in the tool room and for various other uses.



KIPP AIR GRINDER

Dr. Silverman Will Visit Chemical Congress in Belgium

Dr. Alexander Silverman, Head, Department of Chemistry, University of Pittsburgh, sailed August 21 on the *Lafayette*, for Europe. He will visit educational and research institutions in France, Holland and Belgium, and will attend the Tenth Congress of Industrial Chemistry at Liege, Belgium, during the week of September 7 as a delegate from the American Ceramic Society, where he will address the members on Recent Developments in American Glass Manufacture. He will also attend the Tenth International Union of Pure and Applied Chemistry, at Liège, during the week of September 14, as a delegate from the National Research Council and National Academy of Sciences.

A New Laminated Glass Law Suit

The Triplex Safety Glass Company of North America, Inc., Clifton, N. J., are proceeding in court against the Safetee Glass Company of Philadelphia, Pa., alleging infringement of the Benedictus patent No. 1,182,739. This is the same patent that was involved in the Triplex suit against the Duplate Corporation, recently sustained by the United States Circuit Court of Appeals.

Nitrate Cartel

According to a special cable to the *New York Times* more than 98% of European producers of synthetic nitrates have joined together in a new pact regulating production and export quotas and providing for unified price levels. The agreement between the Chilean natural nitrate interests and the German Synthetic Syndicate acting on behalf of the European producers puts 80% of the world's production of nitrate during the coming year under one control.

Ray Godard Opens Headquarters

Ray S. Godard, until recently in engineering and sales work for the H. L. Dixon Company of Pittsburgh and who, as noted in the July issue, recently resigned from that organization, announces that he has opened an engineering office at 1702 Grant Building, Pittsburgh, Pa., and will specialize in glass factory engineering construction and equipment.

Bill of Lading Change

Revision in the form of domestic bills of lading to conform with changes in the law became effective August 1, 1930. Old forms of bills of lading may be used up to December 1, 1930, provided they are stamped with the following clause:

> This shipment is tendered and received subject to the terms and conditions of the Company's Uniform Bill of Lading effective August 1st, 1930. This receipt is NOT NEGOTIABLE and if the shipment is consigned "To Order" must be exchanged for Company's Uniform Order Bill of Lading.

Safety Congress and Exposition

The 19th annual Safety Congress and Exposition under the auspices of the National Safety Council will be held at Pittsburg, September 29 to October 3 at the William Penn and Fort Pitt Hotels, Pittsburgh. A very large attendance of industrialists and safety advisors is expected. The exhibit will be held in the exhibition hall of the William Penn Hotel.

Wage Conference Results

The Annual Wage Conferences between the bottle and container manufacturers' representatives and those of the Glass Bottle Blowers Association of the United States and Canada, resulted in last year's wage scale and working rules being adopted for the ensuing year.

RECENT DISPLAY AT ATLANTIC CITY OF THE DUPONT PRODUCTS, INCLUDING GLASSWARE EMPLOYING THE USE OF ROESSLER AND HASSLACHER CHEMICAL CO. PRODUCTS IN THE MAKING, WHO BUT RECENTLY JOINED THEM.

Mr. Hughes' Report on Plate Glass Production

The report of the Plate Glass Manufacturers Association on the production of polished plate glass for the month of July, 1930, was 8,326,176 sq. ft., as compared with 9,128,216 sq. ft. produced in the preceding month June, 1930, and 13,057,098 sq. ft. produced in the corresponding month last year, July, 1929.

Trade Activities

The Pacific Coast Borax Company is reported to be moving machinery from its Bayonne, N. J. plant to its Los Angeles, Cal. factory where, it is stated, all refining will be done in the future. It is said that an official of the company recently said that, including both domestic and foreign export trades, more than 100,000 tons of borax will be handled by the Los Angeles harbor plant annually. From January to May inclusive, the company is said to have exported within 90% of its entire 65,000 ton output of last year and a new high record of production is confidently expected at the end of the current year.

Gustavus J. Esselen, 73 Newbury Street, Boston, Mass., engaged in chemical research and technical development, announces the opening of new offices and laboratories where he and an experienced staff are continuing to give personal attention to problems submitted them for solution. Dr. Esselen has been in close touch with the glass industry, having carried on a large amount of research work in laminated glass and other of the glass manufacturing industries, well as in other lines. other lines.

The Illuminating Engineering Society, New York, is conducting for its members a course on the fundamentals of architecture. The classes will be held in the School of Architecture, Columbia University, New York, September 8-13, 1930. In view of the interest of the public and its growing appreciation of the principles of design as applied to modern lighting fixtures for households, offices, banks, etc., this course should prove of interest to designers of such equipment.

The Capstan Glass Company, Connellsville, Pa., manufacturers of tumblers and other glassware have awarded the Austin Company, Cleveland, O., a contract for the design and construction of a new warehouse which will take care of peak production. The building will be one-story of steel-frame construction and 140 tons of structural steel will be required. The building will be 116 by 200 feet, and represents a $100,000 investment.

The Olean Glass Company, Olean, N. Y., operating two plants in that city has appointed J. H. Myers, Buffalo, N. Y., to be vice-president and general manager, succeeding Willis B. Snell, Jr., who recently resigned. It is said that a comprehensive investigation of the company's affairs has been made. N. V. V. Franchot and W. A. Dusenbury of Olean are said to be vitally interested in keeping the plant in operation.

Dr. Chi Fang Lai, research fellow at the University of Pittsburgh, has been appointed director of the glass and enamel department of the Central Industrial Laboratory of China by the Nanking Government. Dr. Lai, who obtained his degree at the University of Pittsburgh, collaborated with Professor Silverman, the Head of the Chemical Department in the development of sodium-beryllium glass.

Myers Plate Glass Company, New York, has purchased a three-story plant at 311-19 East 117 Street, which will be remodelled for storage purposes and as a glass distributing plant with cutting, trimming and other departments. The equipment will include conveying and other modern mechanical handling equipment.

The Fostoria Glass Company, Moundsville, W. Va., at the annual meeting of stockholders several weeks ago re-elected the old board of directors for the ensuing year. The board comprises C. B. Roe, W. F. Dalzell, E. T. Hitchman, C. W. Jeffers, Arthur C. Stifel, W. W. Halloway, H. E. Vance.

The Owens-Illinois Glass Company, Huntington (W. Va.) branch, according to a report from that city, shows an increase in earnings of $440,000 compared with the previous year for the predecessor company when the plant was under control of the Owens Bottle Company.

The Owens-Illinois Glass Company, according to a report from Fairmont, W. Va., will establish a mold factory in that city where practically all the molds used by the company's plants will be made. About 75 men will be employed, some coming to Fairmont from other cities.

The Pittsburgh Plate Glass Company, according to a report from Pittsburgh, has appointed B. J. Cassady secretary of the commercial department of which H. B. Higgins is chairman. R. B. Tucker has been made manager of glass sales, F. W. Judson, director of sales.

The Pittsburgh Plate Glass Company, according to unconfirmed rumors emanating from several towns on the Detroit River, have been investigating possible sites for a new factory in that territory.

The Pittsburgh Plate Glass Company's window glass plant at Henryetta, Okla., is successfully producing a large output from their four Fourcault machines recently put into operation.

The Toledo Plate and Window Glass Company, Toledo and Detroit, have changed their capitalization from 300,000 common and 300,000 preferred to 1,000,000 common.

The Harshaw Chemical Company, Cleveland, O., recently opened offices at 123 East 6th Street, Cincinnati, O., with Wm. A. Bauman as sales manager in charge.

Cataract-Sharpe Manufacturing Company, Buffalo, N. Y. acquired several weeks ago the plant of Lewis County Cut Glass Company, of West Virginia.

The Owens-Illinois Glass Company have reported net earnings of $1,871,791, equivalent to $1.78 per share (par $25) for the first six months of this year.

Industrial Publications

Improved Gas Producer Operation. New edition of booklet by L. J. Wing Manufacturing Company, 156 West 14th Street, New York. Of interest to operating men in plants using producer gas as fuel.

The Buffalo Forge Company, Buffalo, N. Y. Bulletin No. 2754. Buffalo Gas Unit Heaters, a four-page pamphlet illustrating and describing the company's latest designs in gas fired unit heaters, copies of which are available to anyone interested.

The L. J. Wing Manufacturing Co., 156 West 14 Street, announces the new edition of their booklet "Improved Gas Producer Operation," which should be of interest to operating men in all plants using producer gas as a fuel. A copy will gladly be furnished to anyone interested without obligation.

The American Refractories Institute through its Secretary, Dorothy A. Texter, Oliver Building, Pittsburgh, Pa., has recently distributed copies of the 8th edition of "Brands of Refractories." This booklet lists every known manufacturer of fire brick in the United States and Canada together with a list of the brand names of their products. Copies may be obtained from the Secretary's office for 25 cents each. The Institute will hold its Fall meeting at the Traymore Hotel, Atlantic City, October 24, 1930.

Recent Deaths

Charles F. Gleason

Charles F. Gleason, vice president of the Gleason-Tiebout Glass Company of 99 Commercial Street, Brooklyn, manufacturers of illuminating glassware, died on Sunday, Aug. 3, at his home, 27 Wilson Avenue, Flushing, Queens, of a stroke of apoplexy suffered on Saturday. His age was 70. He had been in good health until recently.

Born in Weymouth, Mass., the son of John Marshall and Mary J. Gleason, he came to New York in 1880, entering the employ of his uncle, E. P. Gleason, head of the E. P. Gleason Manufacturing Company, makers of glass and brass ware. In 1902, when the Gleason-Tiebout Glass Company succeeded the other firm, Mr. Gleason became its vice president and a director, and his brother, Marshall W. Gleason, its president

Mr. Gleason had resided in Flushing for thirty-six years. He was an elder of the First Presbyterian Church there for many years and in later years a deacon of the First Congregational Church. He is survived by a widow, the former Jennie Dale; a daughter, Mrs. John W. Bickford; a granddaughter, Miss Helen D. Bickford, the last two of Milford, Mass., and his brother.

Funeral services were held at his home on Tuesday, Aug. 5, by the Rev. George D. Egbert, pastor of the First Congregational Church. Burial took place in Milford.

Harry O. Brawner

Swindell Brothers, Baltimore, Md., manufacturers of prescriptions, vials and other varieties of bottles, recently announced the death of their partner, Harry O. Brawner on Monday, August 11, 1930.

David C. Jenkins

President of the D. C. Jenkins Glass Co., Kokomo, Ind., passed away suddenly at his summer home, Culver Island. Funeral Tuesday, Aug. 26th, at 2:30 P. M., from his son's residence, 703 Walnut Street, Kokomo, Ind.

August H. Gaffney

Augustus H. Gaffney, president of the American Plate Glass Corporation, Kane, Pa., died of a heart attack, August 11 at Henderson Harbor, New York. The funeral was held at Kane.

Coming Meetings

The National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York, December 1-6, 1930.

The American Bottlers of Carbonated Beverages will hold a Carbonated Beverage Exposition November 10-14 in the Milwaukee Auditorium, Milwaukee, Wis. Convention sessions will be held in the same building. Among manufacturers of beverage bottles who will be represented are the following:

Chattanooga Glass Co., Chattanooga, Tenn.; Cunningham Glass Co., D. O., Pittsburgh, Pa.; Glenshaw Glass Co., Inc., Glenshaw, Pa.; Laurens Glass Works, Laurens, S. C.; Owens-Illinois Glass Co., Toledo, Ohio; Root Glass Co., Terre Haute, Ind.

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C.

New Zealand—47270, Glassware.
China—47318, Glass, window, for railway cars.
France—46698, Glassware and ceramic machinery.
Canada—46857, Glassware, household.
Domestic—46948, Glassware, kitchen.
El Salvador—46981, Glass beveling and mirror manufacturing machinery.

Inquiries Received

For further information address THE GLASS INDUSTRY.

519. Please let us know who the manufacturers are of a certain Bird Cage Seed Cup which has inscribed on the cup "Tulip Cup. O. L. & Co."

520. We are anxious to get in direct touch with manufacturers of strawholders used by confectionery stores and drug store fountains.

521. I am interested in the names of glass container and bottle manufacturers.

Current Prices of Glass-Making Materials

August 21, 1930

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.34½
Alcohol, denatured	gal.	..	.32
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09⅝
Antimony oxide (Sb_2O_3)	lb.	..	.09⅝
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb.	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.80-1.00
Orange	lb.	..	.90-1.00
Yellow	lb.	..	1.40-1.65
Chromium oxide (Cr_2O_3)	lb.	.24	.24
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.25
Black (CuO)	lb.	..	.23-.27
Black prepared	lb.	..	.22
Cryolite ($Na_3Al\ F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.		.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2, 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	..	.07½-.07¾
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.0450
Black (FeO)	lb.	.04½	..
Kaolin (f.o.b. mine)	ton	9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.08	.09
Litharge (PbO)	lb.	.07	.08
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	..
Burnt (CaO) ground, in bulk	ton	7.00	..
Burnt, ground, in paper sacks	ton	9.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.		2.15-2.25	2.30-2.60
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black—			
for nickel content	lb.	..	.35
Nickel monoxide (NiO), green—			
for nickel content	lb	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¼
Ground	lb.	.11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06½-.06¾
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.19
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.80-1.90
Silver nitrate ($AgNO_3$)	(100 oz.) per oz.	..	.27
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	1.90-2.00
In bags	Per 100 lb.	1.37½-1.40	1.72½
Spot orders .. .025 per 100 lbs. higher		..	..
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.95	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03¾	.04½
95 per cent.	Per 100 lb.	1.99-2.10	2.15-2.25
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.39	.37½
Tin oxide (SnO_2) in bbls.	lb	..	.36-.40
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.08½	.12
American process. Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude. Gran. (Milled .005-.02c higher)		.03¼	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to July 24, 1930

	June 1929 Quantity	June 1929 Value	June 1930 Quantity	June 1930 Value	Six Months Ending June 1929 Quantity	Six Months Ending June 1929 Value	Six Months Ending June 1930 Quantity	Six Months Ending June 1930 Value
Glass and glass products (Total)	.....	$927,858	.....	$757,223	.....	$5,498,357	.....	$4,781,863
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,146	8,666	1,968	8,493	10,686	58,774	10,161	54,447
Plate glass, unsilvered, sq. ft.	212,898	73,848	302,103	75,642	1,154,198	404,795	1,790,607	541,099
Other window and plate glass lbs.	262,927	33,747	351,289	37,633	2,264,557	240,579	2,612,287	249,078
Glass containers (bottles, vials and jars)	.....	352,886	.....	267,495	.....	1,739,186	.....	1,506,572
Table glassware, plain	.....	125,832	.....	92,779	.....	763,676	.....	641,546
Table and other glassware, cut or engraved	.....	8,769	.....	7,263	.....	61,628	.....	49,622
Lamp chimneys and lantern globes lbs.	103,763	19,906	130,889	24,796	774,388	160,456	628,064	121,202
Globes and shades for lighting fixtures lbs.	160,526	57,133	168,002	55,948	1,051,823	385,683	917,315	328,518
Chemical glassware lbs.	23,068	19,616	25,138	21,067	118,901	107,878	120,284	112,560
Electrical glassware, except for lighting lbs.	481,747	45,096	318,377	18,151	3,467,092	264,575	2,680,217	173,620
Other glassware	.....	182,359	.....	147,956	.....	1,311,127	.....	1,003,599

IMPORTS

Corrected to July 24, 1930

Glass and glass products	.....	1,363,097	.....	445,819	.....	6,705,741	.....	4,463,809
Cylinder, crown and sheet—								
Unpolished, not bent, obscured, beveled, etc.—								
Weighing less than 80 pounds per case dut. lb.	6,248,868	173,543	226,317	8,688	23,550,559	619,058	3,373,070	128,278
Weighing 80 pounds or over per case dut. lb.	6,170,590	254,889	523,246	20,367	20,425,025	777,225	7,476,850	295,597
Polished and bent, obscured, beveled, colored, etc., unpolished and polished, and all silvered dut.	.....	70,855	.....	17,766	.....	329,619	.....	193,055
Plate glass—								
Polished, unsilvered dut. sq. ft	628,259	124,399	115,575	23,580	5,309,499	1,141,312	2,663,879	554,351
Other dut. sq. ft.	140,313	26,760	148,668	20,052	733,540	137,312	471,907	138,564
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	12,365	.....	53,670	.....	124,032	.....	676,495
Table and kitchen utensils dut.	.....	34,537	.....	10,811	.....	130,670	.....	80,936
Glassware, cut or decorated dut.	.....	313,799	.....	107,243	.....	1,422,495	.....	834,207
Blown, glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	83,422	.....	52,018	.....	515,222	.....	372,811
Bulbs for electric lamps dut. No. 1	673,791	6,053	663,206	6,099	8,659,816	73,411	7,823,866	72,293
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	57,906	.....	24,433	.....	450,788	.....	309,949
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	65,340	.....	34,737	.....	295,724	.....	284,946
Other glassware dut.	.....	139,229	.....	66,355	.....	688,873	.....	523,327